doi : 10.17596/0003044

MIRAI Cruise Report
MR12-E01

20 Feb. – 3 Mar. 2012

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Acknowledgements

We would like to thank all ship officers and crew of R/V MIRAI and a marine technician of GODI, MWJ and NME for their supports during our cruise. We also thank all support stuff of cruise support division for arranging of this cruise. This cruise was supported by research program titled “The Survey and Observation for Earthquakes and Tsunamis off the Pacific Coast of Tohoku” by MEXT.

MR12-E01 Cruise Report Contents

1. Cruise information and summary of MR12-E01 cruise

Cruise information

Cruise number	MR12-E01
Ship name	R/V MIRAI
Chief scientist	Takafumi Kasaya (IFREE, JAMSTEC)
Date	20 Feb. 2012 – 3 Mar. 2012
Ports of call	Sekinehama (JAMSTEC) – Yokohama
Research Area	Fig.1

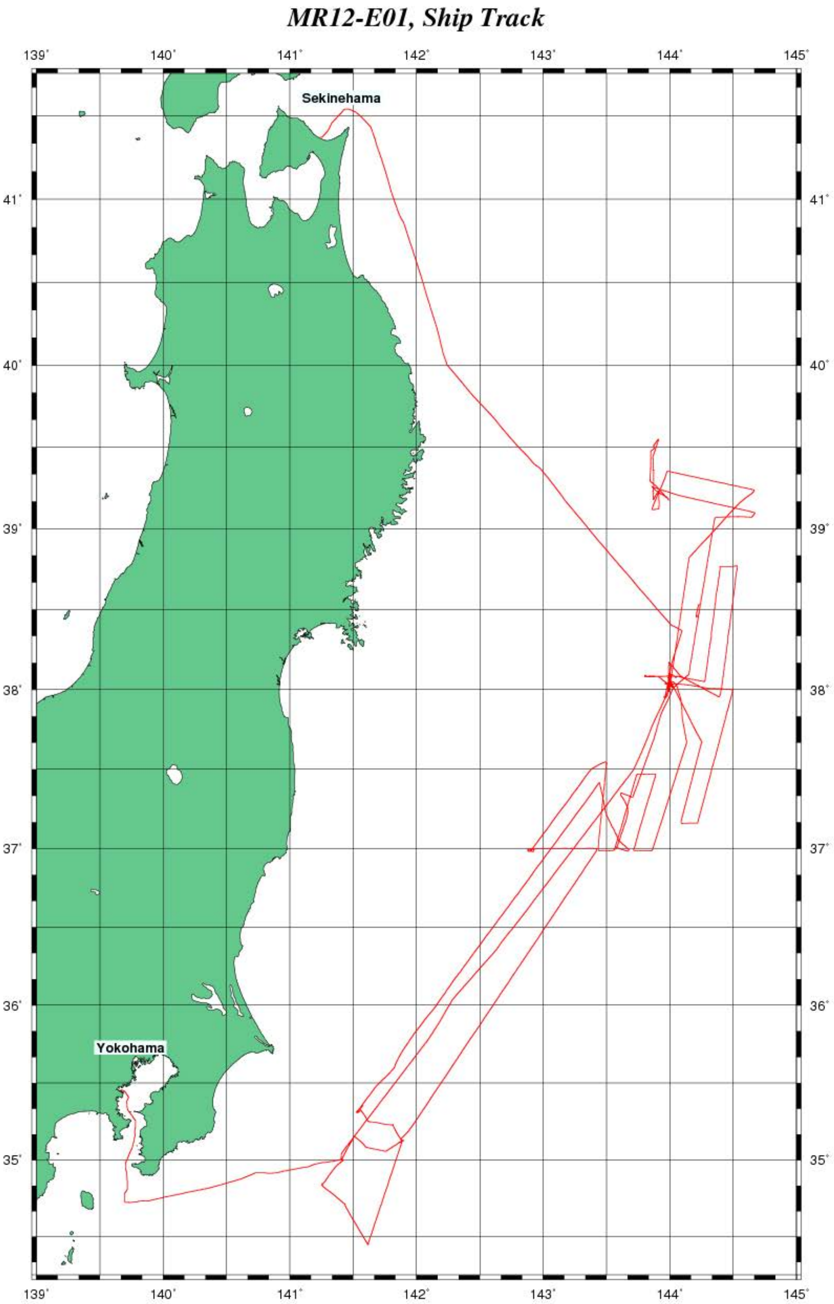

Fig. Ship track of this cruise.

Cruise summary

On 11 March 2011, Tohoku, northeast Japan, experienced a great earthquake (Mw 9.0, Mt 9.1) called the 2011 off the Pacific coast of Tohoku earthquake. Seismic and tsunami inversion analyses have shown that tsunami waves with a maximum run-up height of 38 m were generated after the main shock by topographic changes on the seafloor in the toe region of the Japan Trench slope off Sendai. These inversion analyses (Maeda et al., 2011) and bathymetric surveys (Fujiwara et al., 2011) indicate that the toe region slipped about 50 m along the thrust. If the thrust fault rapidly deformed the seafloor, as suggested by Ide et al. (2011), the basic theory of tsunami-genesis would predict the generation of tsunamis all along the axis of the Japan Trench.

To investigate many phenomena related with the earthquake, research program "The Survey and Observation for Earthquakes and Tsunamis off the Pacific Coast of Tohoku" supported by MEXT has been started in FY 2011.

In this cruise, we carried out bathymetric and geophysical surveys, a piston coring around the Japan Trench axis and two type OBSs deployments. The most prominent result is supplied by a piston coring around the Japan Trench at 38 degrees North. We succeed to obtain six piston core samples with pilot core samples. Longest sample was about 9.5 meters using 10 meters piston coring system. According to the onboard analysis, we could observe turbidite layer, some mud and sand layers related with some past earthquakes and volcanic arch layers. Using the collected bathymetrical data around the Japan Trench area at from 37.5 to 39 degrees North. Preliminary bathymetry map was obtained after velocity corrections and outlier removal operation on board. Moreover, we could set up six Broad band OBSs and eight short period OBSs off the Boso peninsula.

2. List of participants

Onboard Scientists	
Chief Scientist (IFREE / JAMSTEC)	Takafumi Kasaya
Scientist (IFREE / JAMSTEC)	Toshiya Kanamatsu
Scientist (IFREE / JAMSTEC)	Hiroko Sugioka
Scientist (IFREE / JAMSTEC)	Aki Ito
Scientist (IFREE / JAMSTEC)	Koichiro Obana
Scientist (GSJ / AIST)	Tomoyuki Sato
Scientist (Chiba University, JAMSTEC)	Kazuno Arai
Marine Technicians	
Chief Technician (Nippon Marine Enterprises Ltd)	Masato Sugano
Technician (Nippon Marine Enterprises Ltd)	Ikumasa Terada
Technician (Nippon Marine Enterprises Ltd)	Toshinori Saijo
Chief Technician (Marine Works Japan Ltd)	Kazuhiro Yoshida
Technician (Marine Works Japan Ltd)	Naotaka Togashi
Technician (Marine Works Japan Ltd)	Yasushi Hashimoto
Technician (Marine Works Japan Ltd)	Tetsuharu Iino
Chief Technician (Global Ocean Development Inc)	Katsuhisa Maeno
Technician (Global Ocean Development Inc)	Toshio Furuta
R/V MIRAI Crews	
Master	Yasushi Ishioka
Chief Officer	Takeshi Isohi
1st Officer	Hajime Matsuo
2nd Officer	Haruka Wakui
3rd Officer	Hiroki Kobayashi
Chief Engineer	Hiroyuki Suzuki
1st Engineer	Hiroyuki Tohken
2nd Engineer	Keisuke Nakamura
3rd Engineer	Yusuke Kimoto
Technical Officer	Ryo Oyama
Boatswain	Kazuyoshi Kudo
Able Seaman	Takeharu Aisaka
Able Seaman	Masashige Okada
Able Seaman	Shuji Komata
Ordinary Seaman	Hideaki Tamotsu
Ordinary Seaman	Hideyuki Okubo
Ordinary Seaman	Ginta Ogaki
Ordinary Seaman	Masaya Tanikawa
Ordinary Seaman	Hajime Ikawa
Ordinary Seaman	Shohei Uehara
Ordinary Seaman	Tomohiro Shimada
No. 1 Oiler	Sadanori Honda
Oiler	Yoshihiro Sugimoto
Oiler	Kazumi Yamashita
Oiler	Daisuke Taniguchi
Ordinary Oiler	Keisuke Yoshida
Ordinary Oiler	Hiromi Ikuta
Chief Steward	Hitoshi Ota
Cook	Tatsuya Hamabe
Cook	Tamotsu Uemura
Cook	Sakae Hoshikuma
Steward	Shohei Maruyama

3. Ship Log

Date	Time	Description	Position, depth
20-Feb-12	9:00	Depart from the Sekinehama port	
	20:40	Start MBES, SBP survey	
	21:07	XBT	39-22.93N, 142-57.35E
21-Feb-12	4:37	XBT	38-22.31N, 144-05.22E
	8:12	Arrive at PC01 site (Camera 1)	
		Finish MBES, SBP survey	
	9:32	Launch 5 m piston corer (MR12-E01 PC01)	
	11:56	Piston corer on bottom	38-05.19N, 143-59.45E, 7,546 m
	14:36	Piston corer on deck	
		Start MBES, SBP survey	
22-Feb-12	5:12	Arrive at PC02 site (Camera 2)	
		Finish MBES, SBP survey	
	6:45	Launch 5 m piston corer (MR12-E01 PC02)	
	8:48	Piston corer on bottom	38-05.11N, 144.02.63E, 7,249 m
	11:19	Piston corer on deck	
	12:00	Arrive at PC03 site (North 3)	
	12:55	Launch 10 m piston corer (MR12-E01 PC03)	
	15:14	Piston corer on bottom	38-06.09N, 143-59.99E, 7,541 m
	17:58	Piston corer on deck	
	18:00	Start MBES, SBP survey	
23-Feb-12	2:47	Finish MBES, SBP survey	
	3:30	Com'ced drifting	
	6:48	Completed drifting	
	7:38	Start MBES, SBP survey	
	20:24	Finish MBES, SBP survey	
		Com'ced drifting	
24-Feb-12	15:00	Completed drifting	
	15:52	Start MBES, SBP survey	
	16:32	Finish MBES, SBP survey	
	17:53	Start MBES, SBP survey	
25-Feb-12	5:00	Finish MBES, SBP survey	
		Com'ced drifting	
	8:30	Completed drifting	
		Start MBES, SBP survey	

	14:24	Finish MBES, SBP survey	
		Com'ced drifting	
	19:00	Completed drifting	
	19:01	Start MBES, SBP survey	
26-Feb-12	0:18	Finish MBES, SBP survey	
		Com'ced drifting	
	8:18	Completed drifting	
		Start MBES, SBP survey	
27-Feb-12	2:36	Arrive at BBOBS1 site	
		Finish MBES, SBP survey	
		Com'ced drifting	
	2:38	XBT	35-19.11N, 141-32.18E
	5:36	Completed drifting	
	6:09	Deploy BBOBS1	35-18.50N, 141-32.12E, 2,879 m
	7:34	Deploy OBS1	35-19.59N, 141-33.55E, 2,540 m
	8:33	Deploy OBS9	35-15.06N, 141-37.62E, 3,549 m
	9:50	Deploy OBS7	35-13.89N, 141-48.98E, 3,650 m
	10:52	Deploy BBOBS2	35-07.45N, 141-53.32E, 5,612 m
	11:13	Deploy OBS5	35-06.86N, 141-51.87E, 5,817 m
	13:35	Deploy OBS6	35-03.44N, 141-45.13E, 5,532 m
	14:39	Deploy OBS8	35-05.20N, 141-35.84E, 4,683 m
	15:31	Deploy OBS10	35-09.50N, 141-30.42E, 3,532 m
	16:51	Deploy BBOBS4	35-00.05N, 141-24.54E, 3,791 m
	16:56	Deploy OBS2	35-00.57N, 141-24.50E, 3,775 m
	18:24	Start MBES, SBP survey	
28-Feb-12	10:30	Arrive at PC04 site (South 4)	
		Finish MBES, SBP survey	
	11:12	Launch 10 m piston corer (MR12-E01 PC04)	
	13:42	Piston corer on bottom	38-01.52N, 144-00.14E, 7,512 m
	16:18	Piston corer on deck	
		Start MBES, SBP survey	
29-Feb-12	5:30	Arrive at PC05 site (Top 10)	
		Finish MBES, SBP survey	
	6:34	Launch 5 m piston corer (MR12-E01 PC05)	

	8:53	Piston corer on bottom	38-04.50N, 143-59.58, 7,486 m
	11:15	Piston corer on deck	
	11:30	Arrive at PC06 site (Front 9)	
	12:08	Launch 10 m piston corer (MR12-E01 PC06)	
	14:25	Piston corer on bottom	38-02.97N, 144-00.57E, 7,541 m
	16:52	Piston corer on deck	
	17:06	Tow cesium magnetometer	
	17:30	Start MBES, SBP survey	
01-Mar-12	15:15	Start calibration for the magnetometer	36-59.06N, 142-53.97E
	16:09	Finish calibration	
	16:36	Recover cesium magnetometer	
02-Mar-12	5:18	Arrive at BBOBS2 site	
		Finish MBES, SBP survey	
	5:22	Start calibration of BBOBS4 position	
	6:18	Finish calibration	
		Start MBES, SBP survey	
	10:42	Arrive at BBOBS3 site	
	10:46	Deploy BBOBS3	34-26.99N, 141-36.96E
	12:00	Start MBES, SBP survey	
	13:30	Arrive at BBOBS5 site	
	13:37	Deploy BBOBS5	34-42.60N, 141-26.27E
	14:36	Start MBES, SBP survey	
	15:42	Arrive at BBOBS6 site	
		Finish MBES, SBP survey	
	15:50	Deploy BBOBS6	34-50.28N, 141-15.30E
	16:42	Start MBES, SBP survey	
	17:48	Arrive at BBOBS4 site	
	17:48	Start calibration of BBOBS4 position	
	18:24	Finish calibration	
	18:30	Finish MBES, SBP survey	
03-Mar-12	9:00	Arrive at Yokohama port	

4. Istruments

4.1 Shipboard observation system

4.1.1 Bathymetric survey

R/V MIRAI is equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 2112 (SeaBeam Instruments Inc.). The objective of MBES is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets. The system is fully real time motion-compensated to guarantee full coverage even under severe environmental conditions.

Table 4.1.1.1 shows system configuration and performance of SEABEAM 2112.004 and sub-bottom profiler system.

<u>SEABEAM 2112 (12 kHz system)</u>

Frequency: 12 kHz
Transmit beam width: 2 degree
Transmit power: 20 kW
Transmit pulse length: 3 to 20 msec.
Depth range: 100 to 11,000 m
Beam spacing: 1 degree athwart ship
Swath width: 150 degree (max)
120 degree to 4,500 m
100 degree to 6,000 m
90 degree to 11,000 m
Depth accuracy: Within < 0.5% of depth or +/-1m,
whichever is greater, over the entire swath.
(Nadir beam has greater accuracy;
typically within < 0.2% of depth or +/-1m, whichever is greater)

<u>Sub-bottom profiler system</u>

Frequency; 4 kHz
Beam width; 45°×5°
Profiling limit; 75mbsf
Number of pixels; 1000 pix. each for port and stbd

4.1.2 Gravity survey

The local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface. A LaCoste and Romberg air-sea gravity meter S-116 (Micro-G LaCoste, LLC) is equipped on-board R/V Mirai. To convert the relative gravity to absolute one, we measured gravity, using portable gravity meter (CG-5, Scintrex), at Sekinehama as the reference point.

4.1.3 Geomagnetic survey

Three-component magnetometer

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. A shipboard three-component magnetometer system (Tierra Tecnica SFG1214) is equipped on-board R/V MIRAI. Three-axes flux-gate sensors with ring-cored coils are fixed on the fore mast. Outputs from the sensors are digitized by a 20-bit A/D converter (1 nT/LSB), and sampled at 8 times per second. Ship's heading, pitch, and roll are measured by the Inertial Navigation System (INS) for controlling attitude of a Doppler radar. Ship's position (GPS) and speed data are taken from LAN every second.

Table 4.1.3.1 System configuration of MIRAI three component magnetometer system.

<u>Tierra Tecnica SFG1214</u>

SystemRing core: Fluxgate Type
Number of Component: Directly 3 axes

Cable Length: 50 m
Sensor Dimension: φ280×130H mm
Measurement Range: ±100,000 nT
Resolution: 1 nT

Cesium magnetometer

We measured total geomagnetic field using a cesium marine magnetometer (Geometrics Inc., G-882) and recorded by G-882 data logger (Clovertech Co., Ver.1.0.0). The G-882 magnetometer uses an optically pumped Cesium-vapor atomic resonance system. The sensor fish towed 500 m behind the vessel to minimize the effects of the ship's magnetic field. Table 6.6.2-1 shows system configuration of MIRAI cesium magnetometer system.

Table 4.1.3.2 System configuration of MIRAI cesium magnetometer system.

Geometrics G-882 system
Dynamic operating range: 20,000 to 100,000 nT
Absolute accuracy: <±2 nT throughout range
Setting: Cycle rate; 0.1 sec
Sensitivity: 0.001265 nT at a 0.1 second cycle rate
Sampling rate: 1 sec

4.2 Piston coring

The piston corer system (PC), which was utilized in this cruise, consists of 0.9 ton-weight, 5 m-long duralumin barrel(s) with polycarbonate liner tube(s) and a pilot core sampler. The inside diameter (I.D.) of polycarbonate liner tube is 74 mm. The total weight of the system is approximately 1.0 ton. The total barrel length (5 m or 10 m) was decided based on a geological setting of site. For a pilot core sampler, we used a "74 mm diameter-type pilot corer".

In this cruise, we used two types of piston, Normal type (stainless steel body) and Brass body type. Both of pistons are composing of two O-rings (size: P63). The normal type was used for PC01, 03 and 05, and the brass body type was used for PC02, 04 and 06.

Two transponders were set to a winch wire in order to monitor the PC position in water. One is a transponder for 11,000 m water depth with a titan pressure tight case made by the System-Giken ltd., which was set it 50 m or 200 m above the PC system. Another is a glass buoy type transponder for 6,000 m water depth made by the Benthos ltd., which was set 3000 m above the PC system (Fig.4.2.1).

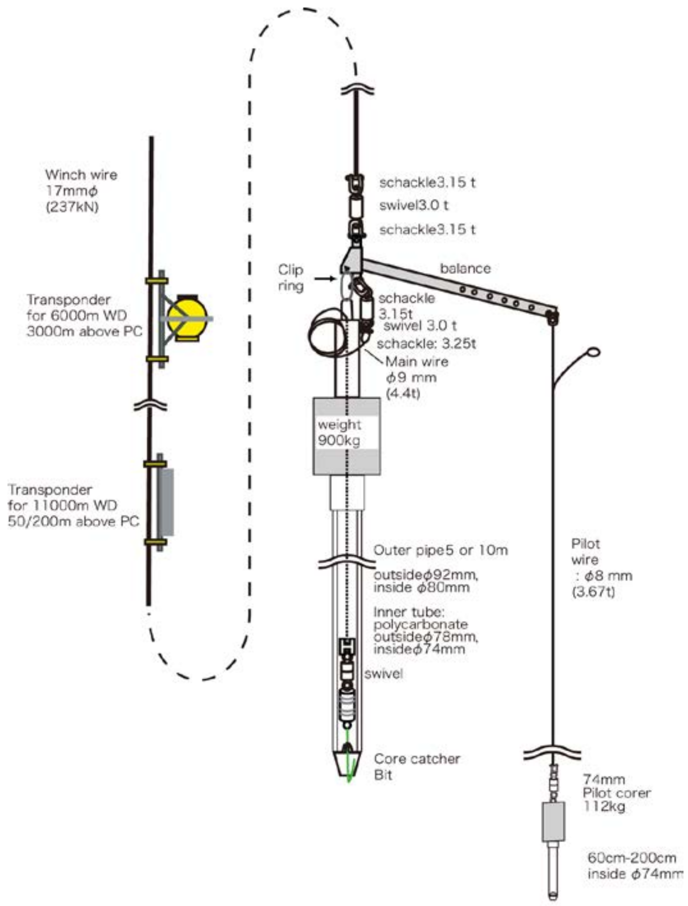

Fig. 4.2.1 Piston coring system in this cruise.

<u>**Instruments and methods**</u>

Winch operation

When we started lowering PC, a speed of wire out was set to be 0.2 m/s., and then gradually increased to the maximum of 1.0 m/s. We stopped wire outing at a depth about 100 m above the seafloor, and waited about 3 minutes to reduce some pendulum motion of the system. Then we restarted wire outing at a speed of 0.3 m/s. When the system touched the bottom, wire tension abruptly decreases by the loss of the PC weight. Immediately after confirmation that the PC hit the bottom, wire out was stopped and winding of the wire was started at a speed of 0.3m/s., until the tension gauge indicates that the PC was liftezd off the bottom. After leaving the bottom, winch wire was wound in at the maximum speed.

MSCL measurements

We measured physical properties of cores using a GEOTEK multi-sensor core logger (MSCL). MSCL has three sensors, which are gamma-ray attenuation (GRA), P-wave velocity (PWV), and magnetic susceptibility (MS). Measurements on every 2 cm on whole round sections were carried out.

GRA was measured by a gamma ray source and detector. These mounted across the core on a sensor stand that aligns them with the center of the core. A narrow beam of gamma ray is emitted by Caesium-137 (^{137}Cs) with energies principally at 0.662MeV. Also, the photon of gamma ray is collimated through 5mm diameter in rotating shutter at the front of the housing of ^{137}Cs. The photon passes through the core and is detected on the other side. The detector comprises a scintillator (a 2" diameter and 2" thick NaI crystal).

GRA calibration assumes a two-phase system model for sediments, where the two phases are the minerals and the interstitial water. Aluminum has an attenuation coefficient similar to common minerals and is used as the mineral phase standard. Pure water is used as the interstitial-water phase standard. The actual standard consists of a telescoping aluminum rob (five elements of varying thickness) mounted in a piece of core liner and filled with distilled water. GRA was measured with 10 seconds counting.

PWV was measured two oil filled Acoustic Rolling Contact (ARC) transducers, which are mounted on the center sensor stand with gamma system. These transducers measure the velocity of P-Wave through the core and the P-Wave pulse frequency.

MS was measured using Bartington loop sensor that has an internal diameter of 100 mm installed in MSCL. An oscillator circuit in the sensor produces a low intensity (approx. 80 A/m RMS) non-saturating, alternating magnetic field (0.565kHz). MS was measured with 1 second.

Core splitting

Whole round sections are longitudinally cut into working and archive halves by a splitting devise and a stainless wire. After that, it marks with the white and blue pins were put in a side of halved sections with 2 cm interval.

CCR measurements

Core color reference (CCR) was measured by using the Konica Minolta CM-700d (CM-700d) reference photo spectrometer using 400 to 700nm in wavelengths. This is a compact and hand-held instrument, and can measure spectral reflectance of sediment surface with a scope of 8mm diameter. To ensure accuracy, the CM-700d was used with a double-beam feedback system, monitoring the illumination on the specimen at the time of measurement and automatically compensating for any changes in the intensity or spectral distribution of the light. The CM-700d has a switch that allows the specular component to be include (SCI) or excluded (SCE). We chose setting the switch to SCE. The SCE setting is the recommended mode of operation for sediments in which the light reflected at a certain angle (angle of specular reflection) is trapped and absorbed at the light trap position on the integration sphere.

Calibrations are zero calibration and white calibration before the measurement of core samples. Zero calibration is carried out into the air. White calibration is carried out using the white calibration piece (CM-700d standard accessories) without crystal clear polyethylene wrap. The color of the split sediment (Archive half core) was measured on every 2-cm through crystal clear polyethylene wrap.

There are different systems to quantify the color reference for soil and sediment measurements, the most common is the $L^*a^*b^*$ system, also referred to as the CIE (Commision International d'Eclairage) LAB system. It can be visualized as a cylindrical coordinate system in which the axis of the cylinder is the lightness variable L^*,ranging from 0% to 100%, and the radii are the chromaticity variables a^* and b^*. Variable a^* is the green (negative) to red (positive) axis, and variable b^* is the blue (negative) to yellow (positive) axis. Spectral data can be used to estimate the abundance of certain components of sediments.

Measurement parameters are displayed Table 4-2-1.

Table 4-2-1. Measurement parameters.

Instrument	Konica Minolta Photospectrometer CM-700d
Software	Spectra Magic NX CM-S100w Ver.2.02.0002
Illuminant	d/8 (SCE)
Light source	D_{65}
Viewing angle	10 degree
Color system	$L^*a^*b^*$ system

Core Photographs

After splitting each section of piston and pilot cores into working and archive halves, sectional photographs of working were taken using a single-lens reflex digital camera (Body: Nikon D90 / Lens: Nikon AF200m Nikkor 24-50mm). When using the digital camera, shutter speed was 1/13 ~ 1/40 sec, F-number was 5.6 ~ 10, sensitivity was ISO 200. File format of raw data is Exif-JPEG. Details for settings were included on property of each file.

4.3 BBOBS

The Broadband Ocean Bottom Seismometer (BBOBS) has been developed at the Earthquake Research Institute (ERI) of the University of Tokyo since 1999 based on the Ocean Bottom Seismometer (OBS) with a geophone. A broadband sensor (CMG-3T for OBS, Guralp, UK) is installed on an active leveling unit developed at the ERI. The data is digitized by a 24 bit ADC with 200 Hz, and recorded on 2.5 inch HDDs with the total capacity of 80 GB. These and about 70 Li cells (DD size) are fixed inside of a titanium sphere housing (D = 65 cm). The BBOBS is deployed by a free fall from the sea surface and pop up by its buoyancy in the recovery. The anchor is released by a forced electrolytic corrosion of two thin titanium plates after receiving a command of an acoustic transponder from the ship. The differential pressure gauge (DPG) is often equipped with the BBOBS.

Table 4.3.1 BBOBS specifications

BBOBS Outside	
Size	1m x 1m x 0.7m (Width x Depth x Height)
Weight in air	240kg (deployment), 150kg (recovery)
Pressure case	Titanium sphere (D=65cm, Buoyancy=70kg, Made in Russia)
Releasing mechanism	Forced electric corrosion of two thin Ti plates (t=0.4mm)
Recovery control	Acoustic transponder system with recorder communication
Recovery aids	Radio beacon (160 MHz band) and Xenon flasher with light switch
BBOBS Inside	
Sensor	CMG-3T for OBS (Guralp, UK) sensor on the active leveling unit
	Period: 360s ~ 100Hz
	Sensitivity: 1500V/m/s
	leveling works up to 20 degree in tilting
Analog unit	gain: 0 dB
	LPF: 32Hz (4th-order Butterworth)
A/D	24bit (0~5V) 200Hz sampling
	Win format like compression
Data media	Two 2.5inch 40GB SCSI HDDs
RTC	0.5ppm, backuped by two

Power supply	DD-size lithium cells (Electro Chem, 3.9V, 30Ah) Sensor: 8 parallels (15.6V, 240Ah) Recorder: 12 parallels (11.7V, 360Ah) DPG: 3 parallels (11.7V, 90Ah)

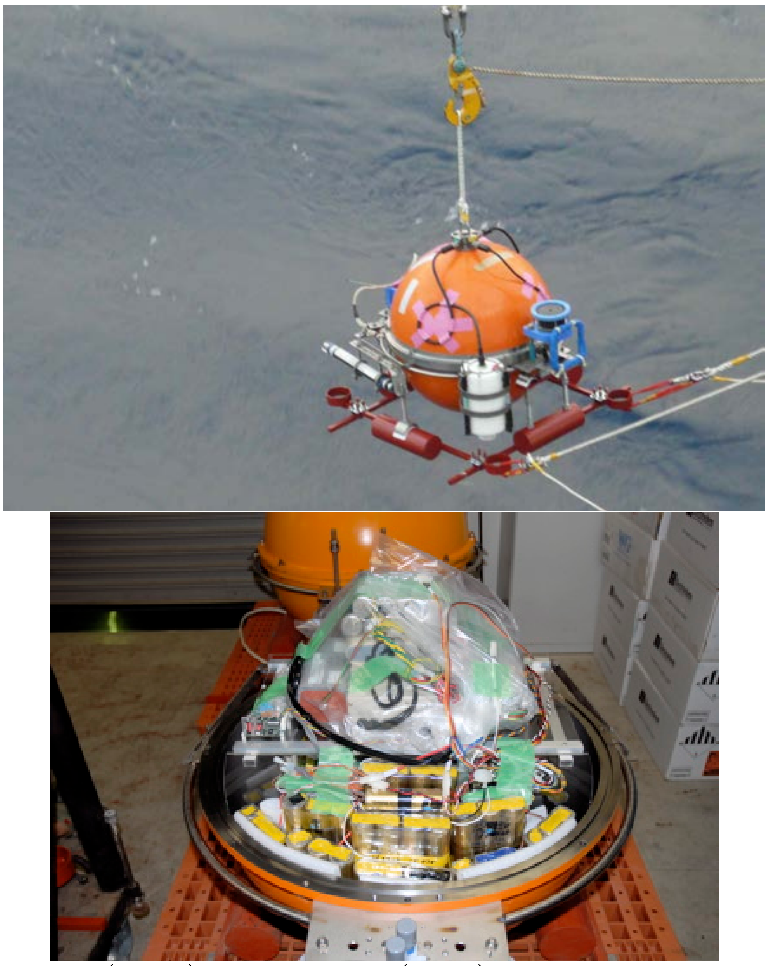

Fig. 4.3.1 The appearance (upper) and the inside (lower) of the BBOBS. The differential pressure gauge (DPG) was equipped with the BBOBS in the upper figure

4.4 OBS

The Ocean Bottom Seismometer (OBS) is equipped with a three-component 4.5-Hz short-period seismometer and a hydrophone. The data is digitized by a 24 bit ADC with 100 Hz. The OBS is deployed by a free fall from the sea surface and pop up by its buoyancy in the recovery. The anchor is released by a forced electrolytic corrosion of a thin stainless steel wire after receiving a command of an acoustic transponder from the ship.

Table 4.4.1 OBS specifications

OCEAN-BOTTOM SEISMOMETER	
Type	TOKYO SOKUSHIN TOBS-24N
Number of Channel	4
ch1	Vertical sensor
ch2 / ch3	Horizontal sensor (two directions)
ch4	Hydrophone
SENSOR	
Type	Geo Space Technologies HS-1LT
Sensitivity	- *1
Damping	80%
Natural Frequency	4.5 Hz
Frequency Tolerance	±0.75 Hz
Coil Resistance	1460 Ω
Coil Current Damping	1910 Ω
HYDROPHONE	
Type - A	HIGH TECH HTI-90-DY
Sensitivity	-170 dB re:1 V/uPa
Frequency Response	2 - 15 kHz
RECORDER	
Type	TOKYO SOKUSHIN DTC6730
Sample Rate	10.0 msec
A/D Converter	24 Bit
Frequency Response	-
Pre Amplifier Gain	
ch1/ch2/ch3/ch4	40 / 40 / 40 / 40 dB
Digital Filter	Linear Phase
Width of quantization step	0.336×10^{-3}
Recording Media	SSD 64GB
Clock Type	MCXO
Clock Frequency	32.768 kHz (3.2768 MHz)
Clock Accuracy	$\pm5*10^{-8}$ sec
Time Reference	GPS
*1	Damping 70%:0.78 V/inch/sec Open :1.22 V/inch/sec

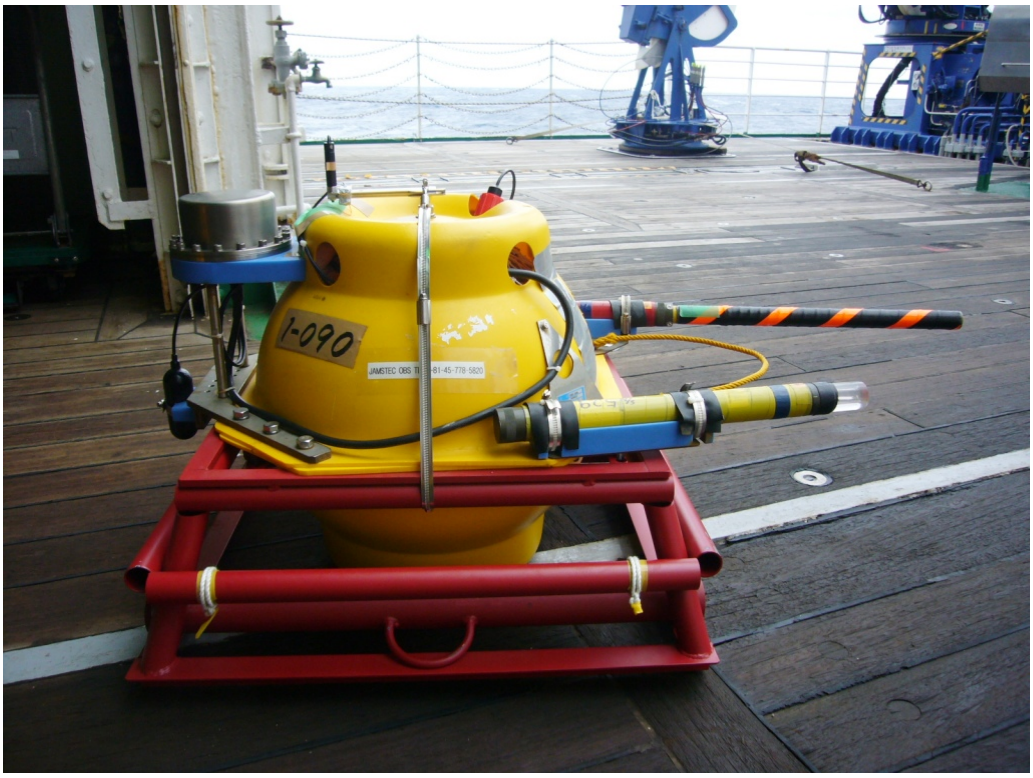

Fig. 4.4.1 The appearance of the OBS

5. Operation report and preliminary results

5.1 Shipboard data

The "SEABEAM 21112" on R/V MIRAI was used for bathymetry mapping during the MR12-E01 cruise from 20th February to 2rd March 2012. Table 5.1.1 shows the information of bathymetric survey lines.

To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data to get the sea surface (6.2m) sound velocity, and the deeper depth sound velocity profiles were calculated by temperature and salinity profiles from CTD or XCTD or ARGO data by the equation in Del Grosso (1974) during the cruise. Table 5.1.2 shows the list of a XBT data obtained in this cruise. We also carried out the subsurface structure acquisition using a sub-bottom profiler (SBP) in all survey line.

Moreover, we measured geomagnetic field using a three-component magnetometer, gravity data through the MR12-E01 cruise. A geomagnetic total force observation only carried out at 1st, May.

Table 5.1.1 Survey line list of this cruise.

Line		Lat	Long
Survey(1)	start	39-20.35	143-00.56
Survey(1)	wp	38-34.24	144-00.54
Survey(1)	end	38-22.13	144-05.69
Survey(2)	start	38-21.87	144-05.74
Survey(2)	Wp	38-00.00	144-00.95
Survey(2)	end	37-57.82	143-57.92
Survey(3)	start	37-58.12	143-58.94
Survey(3)	end	38-05.14	144-00.71
Survey(4)	start	38-05.03	143-50.08
Survey(4)	end	38-04.99	144-04.98
Survey(5)	start	38-04.83	144-05.43
Survey(5)	end	37-57.47	144-22.80
Survey(6)	start	37-58.20	144-23.94
Survey(6)	end	38-45.76	144-32.03
Survey(7)	start	38-46.15	144-31.51
Survey(7)	end	38-46.00	144-24.23
Survey(8)	start	38-45.51	144-23.81
Survey(8)	end	38-03.31	144-16.67
Survey(9)	start	38-06.11	144-09.13
Survey(9)	end	38-28.41	144-13.80
Survey(10)	start	38-28.22	144-13.78
Survey(10)	end	39-03.85	144-21.36
Survey(12)	start	39-05.88	144-40.13
Survey(12)	end	39-14.53	143-55.12
Survey(13)	start	39-21.09	143-59.51
Survey(13)	end	39-14.29	144-39.62
Survey(14)	start	39-13.40	144-39.40
Survey(14)	end	38-49.30	144-09.26
Survey(15)	start	38-48.80	144-09.12
Survey(15)	end	38-00.77	144-59.99
Survey(16)	start	38-00.99	144-01.50
Survey(16)	end	37-29.64	143-47.11
南航 toOBS(17)	start	37-24.83	143-26.31
南航 toOBS(17)	end	35-18.94	141-32.02
OBS	start	35-19.52	141-33.46

OBS	wp	35-14.93	141-37.31
OBS	wp	35-13.65	141-48.67
OBS	wp	35-07.39	141-53.16
OBS	wp	35-03.47	141-45.17
OBS	wp	35-05.15	141-35.92
OBS	wp	35-09.46	141-30.33
OBS	wp	35-00.48	141-24.67
OBS	end	35-02.54	141-24.40
北航 toPiston(18)	start	35-03.14	141-24.91
北航 toPiston(18)	wp	37-29.74	143-42.75
北航 toPiston(18)	end	37-59.29	143-58.93
ピストンから移動(19)	start	38-02.10	144-03.80
ピストンから移動(19)	end	38-00.00	144-29.25
Survey(20)	start	37-59.46	144-29.77
Survey(20)	end	37-09.82	144-13.16
Survey(21)	start	37-09.57	144-12.74
Survey(21)	end	37-09.51	144-05.72
Survey(22)	start	37-10.09	144-05.38
Survey(22)	end	37-40.25	144-15.15
ピストンに移動(23)	start	37-40.50	144-15.08
ピストンに移動(23)	end	38-00.71	144-02.00
ピストンから移動(24)	start	37-48.54	144-06.07
ピストンから移動(24)	end	37-40.00	144-08.05
Survey(25)	start	37-39.88	144-07.97
Survey(25)	end	36-59.40	143-51.63
Survey(26)	start	36-59.13	143-51.23
Survey(26)	end	36-59.13	143-43.27
Survey(27)	start	36-59.54	143-42.82
Survey(27)	end	37-27.55	143-53.28
Survey(29)	start	37-25.37	143-43.32
Survey(29)	end	36-59.74	143-33.89
Survey(30)	start	36-59.32	143-33.22
Survey(30)	end	36-59.02	143-26.94
Survey(31)	start	37-00.03	143-26.09
Survey(31)	end	37-32.17	143-30.07
Survey(32)	start	37-29.98	143-22.74
Survey(32)	end	36-59.97	142-54.92
Survey(33)	start	36-59.74	142-53.80
Survey(33)	end	37-00.01	143-24.77
OBS へ南航(34)	start	36-59.16	143-25.28
OBS へ南航(34)	end	35-08.29	141-52.65
Survey(35)	start	35-07.39	141-53.16
Survey(35)	end	34-33.61	141-39.59
BBOBS05 へ移動(36)	start	34-27.05	141-36.84
BBOBS05 へ移動(36)	end	34-42.42	141-26.19
BBOBS06 へ移動(37)	start	34-42.79	141-26.00
BBOBS06 へ移動(37)	end	34-50.11	141-15.28
BBOBS04 へ移動(38)	start	34-50.70	141-15.70
BBOBS04 へ移動(38)	end	34-59.91	141-25.18

Table 5.1.2 Sound velocity profile list.

Time [UTC]	SVP File	Source File	適用 File [sb*****.mb41]
02:35	1108_39.4n145.9e_ctd_feb04	–	201202200236
12:29	12E01_39.4n143.0e_xbt_feb20	201202201206.XBT	201202201229
19:53	12E01_38.4n144.1e_xbt_feb20	201202201936.XBT	201202201953
17:35	12E01_35.3n141.5e_xbt_feb26	201202261735.XBT	201202261753
01:59	12E01_38.4n144.1e_xbt_feb20	–	201202280159

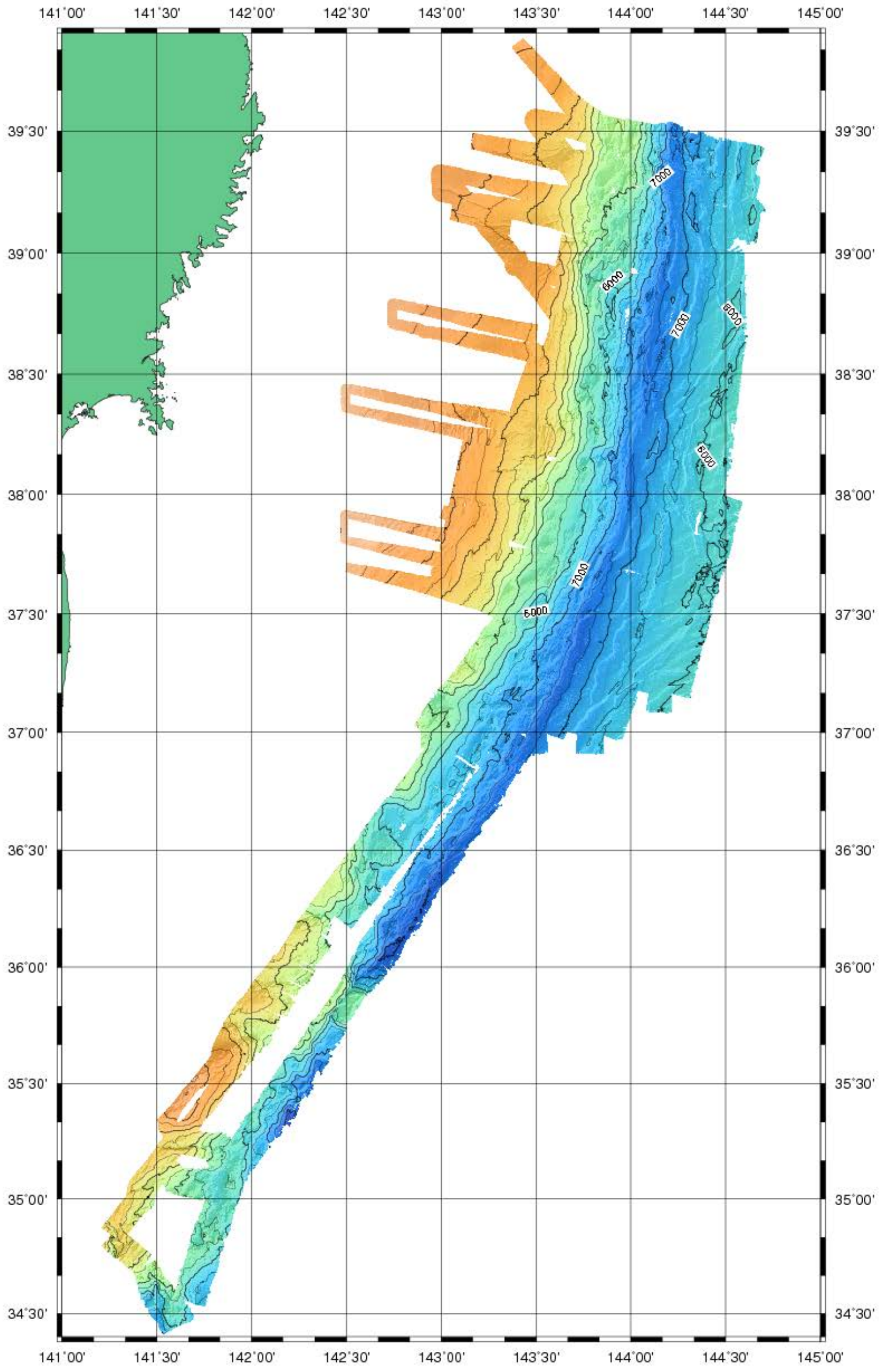

Fig. 5.1.1 Compiled bathymetric map using the YK11-E06 cruise and this cruise data.

5.2 Piston coring

5.2.1 Operation

A deferential bathymetric study between before and after the earthquake revealed large coseismic displacements (up to 50 m horizontally) of the overriding plate, and a possible landsliding induced by the earthquake in the trench axis (Fujiwara et al., 2011). In such seafloor, we believe event deposits (e.g. slump, debris, or turbidite) should be formed, and they could be regarded as a proxy of mega-earthquake like 3.11 earthquake.

In order to characterize the sediments formed or disturbed by 3.11 earthquake, several sediment coring operations were conducted around a topographic high regarded as the landslide block in the deep trench axis (Figure 5.2.1.1, Table 5.2.1.1).

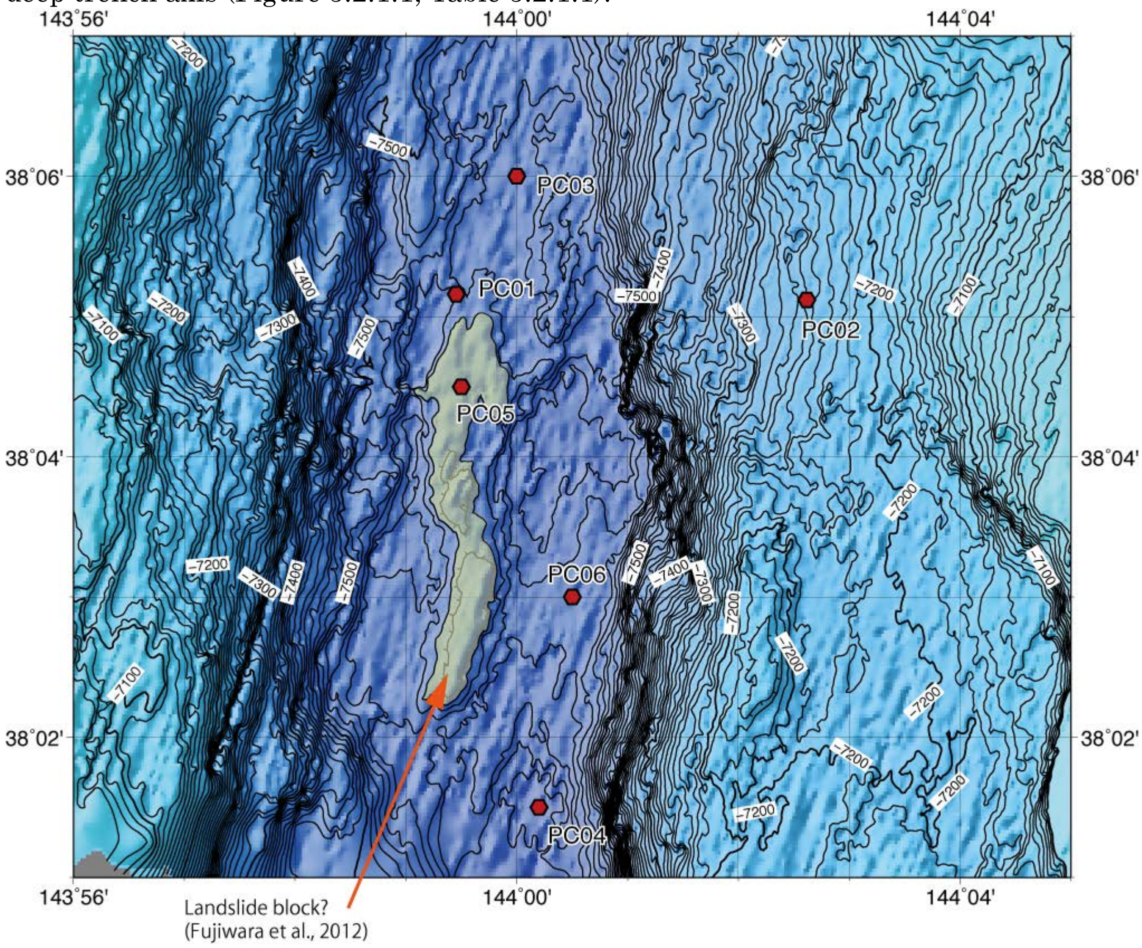

Figure 5.2.1.1: Location of six *piston* cores collected during "MR12-E01"

Table 5.2.1.1 Coring summary MR12-E01 cruise.

Table A Coring Summary_MR12-E01 cruise

Date (UTC) (yymmdd)	Core ID	Corer type*	Location	Lat. (TP**)	Lon. (TP**)	Lat. (Ship)	Lon. (Ship)	Depth (m)	Corebarrel length (m)	Tension max. (t)	Core length (cm)
2012/2/21	PC01	Inner type PC	Off Sanriku (Camera 1)	38°05.1540'N	143°59.4602'E	38°05.1879'N	143°59.4466'E	7,546	5	8.0	440.9
	PL01	74 diam. corer							0.7		54.0
2012/2/21	PC02	Inner type PC	Off Sanriku (Camera 2)	38°05.1239'N	144°02.6097'E	38°05.1192'N	144°02.6381'E	7,249	5	8.4	458.2
	PL02	74 diam. corer							0.7		53.2
2012/2/22	PC03	Inner type PC	Off Sanriku (North 3)	38°05.9916'N	143°59.9781'E	38°06.0426'N	143°59.9913'E	7,541	10	8.0	948.6
	PL03	74 diam. corer							0.7		98.0
2012/2/28	PC04	Inner type PC	Off Sanriku (South 4)	38°01.4348'N	144°00.2359'E	38°01.5168'N	144°00.1446'E	7,554	10	8.3	961.1
	PL04	74 diam. corer							0.7		75.0
2012/2/28	PC05	Inner type PC	Off Sanriku (Top 10)	38°04.4927'N	143°59.4269'E	38°04.5068'N	143°59.5845'E	7,517	5	8.0	469.7
	PL05	74 diam. corer							0.7		86.0
2012/2/29	PC06	Inner type PC	Off Sanriku (Front 9)	38°03.0143'N	144°00.4309'E	38°02.9667'N	144°00.5661'E	7,541	10	8.0	923.2
	PL06	74 diam. corer							0.7		78.0

*Weight of the PC is 900 kg.

**"TP" is position by the transponder, PC01~PC03 are Glass buoy type above 3,000 m from PC, PC04~PC06 are Titan type above 200 m from PC.

5.2.2 Piston core samples

Piston core samples were collected at six sites at Japan Trench, northeast Japan using 5 m and 10 m piston-corer systems operated by Marine Work Japan Co. Ltd. The piston corer system has a pilot corer, so that a piston core sample and a pilot core sample were collected from one coring site. Sample names of the piston cores and pilot cores are MR12-E01 PC01, 02, 03, 04, 05, 06 and PL01, 02, 03, 04, 05, 06 in this description.

The piston core and pilot core samples were processed as follow;

1) Cut the whole core into 1 m sections.
2) Measure core thickness, γ-ray attenuation, P-wave velocity, magnetic susceptibility using Multi-Sensor Core Logger (MSCL) system, Geotek Ltd.
3) Split the whole core into ARCHIVE half and WORKING half.
4) ARICHIVE half: measure digital color.
5) WORKING half: describe sedimentary structure by naked eyes and smear slides (horizons of smear slide are shown in next tables).
6) Take photographs.
7) Pack cores into D-tubes.

The recovered six core samples are described in detail below.

MR12-E01PC01 2012/02/21 Camera 1

Sec	Sec.depth	Core depth	Lithology	Name	Remarks
1	3.0	3.0	surface brown mud		
1	9.0	9.0	darker mud		
1	18.0	18.0	mud		
1	28.0	28.0	mud		
1	30.5	30.5	black layer	silty clay with diatom / spicules	
1	38.0	38.0	mud		
1	43.0	43.0	mud		
2	2.0	47.4	mud		
2	20.0	65.4	mud	diatom silty clay	
2	33.7	79.1	black burrow	silty clay with diatom / spicules	Many black fragment
2	38.0	83.4	mud		
2	39.5	84.9	black layer		
2	41.0	86.4	black layer (sand)		
2	51.0	96.4	mud		
2	63.0	108.4	mud		
2	71.0	116.4	mud		
2	80.0	125.4	mud	diatom silty clay	
2	90.0	135.4	mud		
2	99.0	144.4	black layer	silty clay with diatom / spicules	
2	100.0	145.4	mud		
3	2.5	148.4	black layer	silty clay with diatom / spicules	black fragment
3	15.5	161.4	mud		
3	39.2	185.1	mud		
3	60.0	205.9	mud		
3	84.5	230.4	white bed	diatom ooze - diatom silty clay	
3	94.0	239.9	mud		
4	10.0	255.9	mud		
4	20.0	265.9	mud	diatom clayey silt	
4	36.0	281.9	black lens		
4	40.5	286.4	grayish olive		
4	42.5	288.4	mud		
4	50.0	295.9	mud		
4	70.0	315.9	mud		
4	80.0	325.9	mud		
4	90.0	335.9	mud		
5	25.0	370.9	mud	diatom clayey silt	
5	85.0	430.9	mud		
PL	5.0	5.0	brown mud (upper bed)		
PL	8.0	8.0	brown mud (lower): uppermost white bed	diatom ooze	
PL	14.0	14.0	brown mud (lower): upper part of grading layer		
PL	22.0	22.0	brown mud (lower): base		
PL	29.0	29.0	mud		
PL	51.0	51.0	mud		

Table 5.2.2.1: Description of smear slides (PC01 and PL01)

MR12-E01PC02 2012/02/22 Camera 2

Sec	Sec.depth	Core depth	Lithology	Name	Remarks
1	2.0	2.0	uppermost mud		
1	3.5	3.5	yellowish bed inserted within olive mud		
1	30.0	30.0	mud	diatom silty clay	
1	53.5	53.5	ash?		pumice
1	57.0	57.0	mud		
2	50.0	112.0	mud	silty clay with diatom / volcanic clast	
3	15.0	177.3	mud		
3	34.0	196.3	greenish gray layer		
3	70.0	232.3	mud	diatom silty clay	
3	96.0	258.3	ash?		volcanic glass
3	100.0	262.3	mud		
4	52.5	315.7	black layer	?	
4	80.0	343.2	mud	diatom silty clay	volcanic glass ?
5	15.0	378.2	mud		
5	27.0	390.2	ash?		pumice
5	31.0	394.2	mud	diatom silty clay	volcanic glass ?
5	58.0	421.2	ash?		pumice, volcanic glass
5	80.0	443.2	mud	diatom silty clay	
PL	1.0	1.0	surface brown layer		
PL	2.0	2.0	surface olive layer		
PL	3.3	3.3	graded? bed upper		
PL	4.0	4.0	graded? bed lower		
PL	7.0	7.0	graded? bed upper		
PL	9.0	9.0	graded? bed lower		
PL	13.0	13.0	darker mud layer		
PL	30.0	30.0	mud		

Table 5.2.2.2: Description of smear slides (PC02 and PL02)

MR12-E01PC03 2012/02/22 North 3

Sec	Sec.depth	Core depth	Lithology	Name
1	2.0	2.0	uppermost mud	
1	12.0	12.0	convoluted dark layer	
1	30.0	30.0	mud	
1	33.0	33.0	dark layer	diatom silty clay
1	43.0	43.0	mud	
2	8.0	57.4	mud	diatom silty clay
2	30.0	79.4	dark mud	diatom silty clay
2	44.0	93.4	mud	
2	64.0	113.4	mud	
2	94.0	143.4	mud (low water %?)	diatom silty clay
3	5.0	154.8	mud	diatom silty clay
3	29.5	179.3	mud	
3	40.0	189.8	mud	
3	43.7	193.5	white layer	diatom ooze
3	45.0	194.8	mud (low water %?) below white layer: upper	
3	47.0	196.8	mud (low water %?) below white layer: lower	
3	80.0	229.8	mud (low water %?)	
4	20.0	267.8	mud (low water %?)	
4	80.0	327.8	mud (low water %?)	diatom silty clay
5	26.0	374.1	mud (low water %?)	
5	93.0	441.1	mud (low water %?) with faint bedding	
6	20.0	467.5	mud	diatom silty clay
6	25.5	473.0	ash?	
6	29.0	476.5	mud above white layer	
6	31.0	478.5	white layer: upper	spicules ooze with diatom
6	32.0	479.5	white layer: lower	
6	35.0	482.5	brownish mud below white layer	
6	65.0	512.5	mud	
7	7.0	555.0	mud	diatom silty clay
7	12.0	560.0	sandy bed	
7	45.0	593.0	dark mud	diatom silty clay
7	80.0	628.0	mud inserted within black bed	
8	24.0	672.0		diatom silty clay
8	54.0	702.0	brown mud	diatom silty clay
8	66.0	714.0	cross laminated sand	sand
8	69.0	717.0	brown mud	diatom silty clay
8	88.0	736.0	thin black layer	silty clay
8	94.0	742.0	brown mud	silty clay
9	50.0	798.5	brown mud	silty clay
10	25.0	874.2	brown mud	
10	76.0	925.2	brown mud	silty clay
PL	3.0	3.0	uppermost mud	
PL	4.3	4.3	white layer	diatom ooze – diatom silty clay
PL	7.0	7.0	mud below white layer (grading?)	
PL	9.0	9.0	white layer	diatom ooze – diatom silty clay
PL	12.0	12.0	mud below white layer (grading?)	
PL	25.0	25.0	base of grading bed	
PL	26.3	26.3	mud below grading bed	
PL	27.0	27.0	white layer	diatom ooze – diatom silty clay
PL	29.0	29.0	mud below white layer (grading?)	
PL	30.0	30.0	white layer	diatom ooze
PL	32.0	32.0	mud below white layer (grading?)	
PL	34.0	34.0	uppermost part of grading bed	
PL	40.0	40.0	middle part of grading bed	diatom silty clay
PL	45.0	45.0	middle part of grading bed	
PL	50.0	50.0	lower part of grading bed	
PL	57.0	57.0	base of grading bed	Sand-silt-clay
PL	65.0	65.0	mud below brown grading bed	
PL	85.0	85.0	mud	

Table 5.2.2.3: Description of smear slides (PC03 and PL03)

MR12-E01PC04 2012/02/28 South 4

Sec	Sec.depth	Core depth	Lithology	Name
1	5.0	5.0	uppermost mud	diatom silty clay
1	28.0	28.0	brownish mud	silty clay
1	31.0	31.0	mud	diatom silty clay
1	38.0	38.0	mud	diatom silty clay
1	56.0	56.0	dark mud	diatom silty clay
2	5.0	65.8	dark mud	silty clay w. diatom
2	25.0	85.8	mud	diatom silty clay
2	70.0	130.8	mud	diatom ooze
2	92.0	152.8	light mud	diatom ooze
2	98.0	158.8	mud	diatom ooze
3	35.0	196.8	dark mud	diatom ooze
3	39.0	200.8	mud	diatom ooze – diatom silty clay
3	70.0	231.8	mud (light?)	diatom ooze – diatom silty clay
3	90.0	251.8	mud (low water %?)	diatom silty clay
3	93.0	254.8	white layer	diatom ooze
4	96.0	257.8	mud (low water %?)	diatom silty clay
3	97.5	259.3	white layer	diatom ooze
3	99.0	260.8	mud (low water %?)	diatom silty clay
4	20.0	281.8	mud (low water %?)	silty clay w. diatom
4	90.0	351.8	mud (low water %?)	silty clay
5	10.0	372.8	mud	clayey silt
6	36.0	398.8	mud	silty clay
5	88.0	450.8	dark mud	silty clay
6	2.0	463.3	mud	silty clay w. diatom
6	25.5	486.8	ash?	clayey silt
6	30.0	491.3	mud	diatom ooze – diatom silty clay
6	70.0	531.3	dark mud	diatom ooze – diatom silty clay
7	25.0	585.8	mud	diatom silty clay
7	52.5	613.3	white layer	diatom ooze
7	65.0	625.8	mud	diatom ooze – diatom silty clay
7	84.0	644.8	white layer	diatom silty clay
7	94.0	654.8	mud	clayey silt
8	25.0	687.3	mud	silty clay
8	36.5	698.8	dark mud	silty clay
8	50.0	712.3	mud	silty clay
8	58.0	720.3	mud	clayey silt
8	59.5	721.8	sand	silty sand
8	62.0	724.3	mud	silty clay
8	64.5	726.8	sand	silty clay
8	67.0	729.3	mud	silty clay
8	69.0	731.3	sand	silty sand
8	71.0	733.3	mud	silty clay w. diatom
9	20.0	782.8	mud (light)	silty clay
9	80.0	842.8	mud (dark)	silty clay
10	20.0	882.6	mud	silty clay
10	50.0	912.6	mud	silty clay
10	95.0	957.6	mud	silty clay
PL	2.0	2.0	uppermost mud	diatom ooze
PL	3.0	3.0	white layer	diatom ooze
PL	3.5	3.5	mud below white layer (grading?)	diatom ooze
PL	5.5	5.5	white layer	diatom ooze
PL	33.0	33.0	mud below white layer (grading?)	diatom silty clay
PL	36.0	36.0	base of grading bed	silty clay
PL	38.5	38.5	mud below grading bed	diatom silty clay
PL	50.0	50.0	mud	diatom silty clay

Table 5.2.2.4: Description of smear slides (PC04 and PL04)

MR12-E01PC05 2012/02/29 Top 10

Sec	Sec.depth	Core depth	Lithology	Name
1	4.0	4.0	uppermost mud	diatom silty clay
1	7.0	7.0	base of uppermost sandy mud	diatom clayey silt
1	14.0	14.0	mud	diatom silty clay
1	36.0	36.0	mud	diatom silty clay
1	61.5	61.5	sandy mud	diatom silty clay
1	63.0	63.0	mud	diatom silty clay
2	20.0	84.0	mud	diatom silty clay
2	46.0	110.0	dark mud	diatom ooze – diatom silty clay
2	56.0	120.0	sand	sand
2	58.0	122.0	mud (grading?)	clayey silt
2	60.0	124.0	sand	diatom ooze – diatom silty clay
2	61.0	125.0	mud (grading?)	diatom silty clay
2	63.0	127.0	black layer	diatom ooze – diatom silty clay w. spicule
2	81.0	145.0	dark mud	silty clay
2	83.5	147.5	black burrow	sand
3	15.0	179.0	mud	diatom silty clay w. spicule – diatom ooze
3	30.0	194.0	mud	diatom ooze – diatom silty clay w. spicule
3	30.5	194.5	sandy mud	diatom ooze
3	31.0	195.0	mud (grading?)	diatom ooze
3	65.0	229.0	mud	silty clay
4	30.0	294.7	mud	diatom silty clay
5	50.0	414.7	mud	silty clay w. diatom
5	92.0	456.7	mud	clayey silt
5	93.0	457.7	black layer	silty sand
5	93.5	458.2	mud	silty clay
5	94.0	458.7	mud	silty sand
5	95.5	460.2	black layer	silty sand
5	96.2	460.9	mud	silty clay w. diatom
PL	6.0	6.0	uppermost mud	silty clay w. diatom
PL	8.5	8.5	white layer	silty clay w. diatom spicule – diatom ooze
PL	9.5	9.5	mud below white layer (grading?)	silty clay w. diatom spicule
PL	33.0	33.0	base of grading mud	silty clay
PL	33.5	33.5	base of sandy part	Sand-silt-clay
PL	53.0	53.0	sandy layer	silty clay

Table 5.2.2.5: Description of smear slides (PC05 and PL05)

Sec	Sec.depth	Core depth	Lithology	Name	Remarks
1	30.0	30.0	mud	silty clay	sandy
1	65.0	65.0	mud	silty clay	
1	71.0	71.0	mud	silty clay – ooze	
1	80.0	80.0	mud	silty clay – ooze	
2	41.5	132.5	sand lamina	sand	
2	64.5	155.5	ash?	silty clay	pumice, volcanic glass
2	96.5	187.5	mud	clayey silt	
3	19.0	210.0	sand lamina	sand	
3	44.0	235.0	black sandy layer	clayey silt	black fragment
3	49.5	240.5	light mud	silty clay	
3	63.0	254.0	mud	silty clay	cocolith
3	96.0	287.0	mud	silty sand	
3	99.0	290.0	mud	silty clay	sandy
4	9.0	300.2	dark mud	clayey silt	cocolith, black fragment
4	34.5	325.7	white layer	diatom ooze	
4	35.0	326.2	mud (grading ?)	diatom ooze	spicule
4	35.5	326.7	white layer	diatom ooze	spicule
4	36.0	327.2	mud (grading ?)	silty clay	
5	54.0	445.2	light mud	diatom ooze – diatom silty clay	
5	76.0	467.2	mud	silty clay	
6	40.0	535.8	mud	clayey silt w. diatom	
7	19.0	618.3	mud	silty clay w. diatom	sandy
7	90.0	689.3	mud	silty clay w. diatom	volcanic glass
8	70.0	775.3	mud	silty clay w. diatom	
8	96.0	801.3	mud	clayey silt	black fragment
9	6.0	815.3	sand (base)	sand	
9	23.8	833.1	uppermost part of grayish layer	silty clay w. diatom /spicule – ooze	volcanic glass
9	25.0	834.3	middle part of grayish layer	silty clay	upward fining
9	26.0	835.3	base of grayish layer	clayey silt	diatom, spicule
9	84.0	893.3	mud	silty clay	spicule
9	96.0	905.3	mud	silty clay	diatom, spicule
10	7.0	917.2	sandy mud	silty clay	sandy
PL	0.5	0.5	whitish part pf uppermost mud	ooze	finer than below sample
PL	2.5	2.5	base of uppermost mud	clayey silt w. spicule	
PL	3.0	3.0	white layer	ooze	
PL	4.4	4.4	base of grading bed	clayey silt	diatom
PL	4.5	4.5	white layer	ooze	finer than below sample
PL	6.0	6.0	upper part of grading bed	ooze	diatom, spicule
PL	25.0	25.0	middle part of grading bed	silty clay	sandy
PL	33.5	33.5	base of grading bed	silty clay	silicious grain rich
PL	64.0	64.0	mud	silty clay	diatom, spicule

Table 5.2.2.6: Description of smear slides (PC06 and PL06)

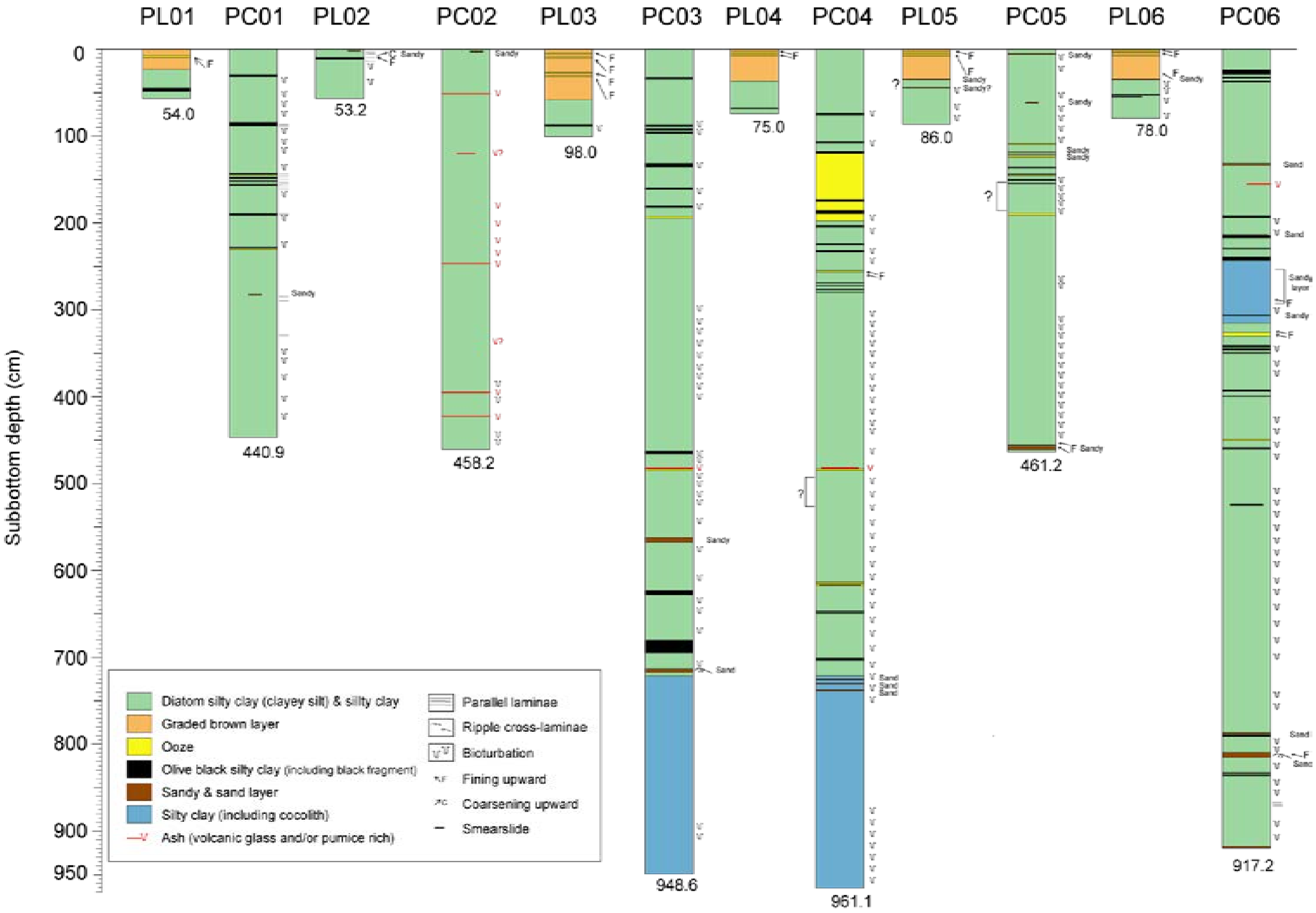

Figure 5.2.2.1: Lithological column of the cores of this cruise.

[PL01 and PC01]

PL01and PC01 were conducted on the north of the block like landslide deposit (Fujiwara et al., 2012), a coring point of YK11-E06 leg1 (Camera 1) at Japan Trench, at 38°05.1540'N and 143°59.4602'E. The water depth was 7546 m.

The pilot and piston cores are 54.0 cm and 440.9 cm long, respectively. Mounds of mud are seen at the tops of PL01 and PC01. The pilot and piston core sediment consist of graded dark olive (brownish) silty clay unit and olive black diatom silty clay unit. Graded dark olive silty clay unit is the several successions of dark olive silty clay (diatom silty clay) and olive yellow silty clay and clay (diatom ooze or ooze), fining upward from dark olive silty clay to olive yellow silty clay. Olive black (7.5Y3/2 or 10Y3/2) diatom silty clay unit is composed of mostly clay particles, diatom, and sponge spicules. This sediment has a lot of biotarbation (burrows), and is interbedded with olive black (7.5Y2/1) silty clay, composed of black fragment, clay particles, diatom, and sponge spicules. The magnetic susceptibility is fluctuated between 5 and 49 SI $\times 10^{-8}$ m^3kg^{-1} and that of PC01 has five large peaks. The magnetic susceptibility of PL01 and section 1 – 3 of PC01 vary significantly, but that of section 4 – 5 of PC01 varies a little.

[PL02 and PC02]

PL02 and PC02 were conducted on the trench slope at the east of Japan Trench, a coring point of YK11-E06 leg1 (Camera 2) at 38°05.1239'N and 144°2.6097'E. The water depth was 7249 m.

The pilot and piston cores were recovered 53.2 and 458.2 cm long, respectively. The pilot and piston core sediments consist of olive black (7.5Y3/2 or 10Y3/2) diatom silty clay and silty clay. Olive black silty clay is composed of mostly clay particles, diatom, and sponge spicules. Whitish volcanic ash layers and patches are seen at 53 – 54, 256.3 – 258.8, 389.2 – 391.2, and 420.2 – 423.2 cm of PC02. The magnetic susceptibility is fluctuated between 13 and 130 SI $\times 10^{-8}$ m^3kg^{-1}. The magnetic susceptibility of PL02 has two peaks at around 14 and 50 cm. Whitish volcanic ash layers (except last one) are shown high magnetic susceptibility values (90 – 130 SI $\times 10^{-8}$ m^3kg^{-1}).

[PL03 and PC03]

PL03 and PC03 were conducted on the north of the block like landslide deposit (Fujiwara et al., 2012) and PC01 at Japan Trench, at 38°5.9916'N and 143°59.9781'E. The water depth was 7541 m. The pilot and piston cores are 98.0 and 948.6 cm long, respectively. The pilot and piston core sediment consist of graded grayish olive (brownish) silty clay unit, olive black diatom silty clay unit and grayish olive silty clay unit. Graded grayish olive unit are the several successions of dark olive brown sandy silt, (dark) grayish olive silty clay and (light) grayish olive clay, fining upward. Olive black (7.5Y3/2 or 10Y3/2) diatom silty clay unit is same as PL01 and PC01. This sediment has a lot of biotarbation (burrows), and is interbedded with olive black layers (including black fragments), light grayish olive layers (ooze) and olive black sand and sandy layers. Grayish olive silty clay unit is composed of clay particles, diatom and a few cocolith. Volcanic ash layer is seen at 472.5 – 473.5 cm of PC03. Light grayish olive layers (ooze) are seen at 193.5, 478.5 cm. Olive black sand and sandy layers are seen at 560.0 – 564.0 and 712.0 – 718.0 cm, and lower one has ripple cross-lamination.

The magnetic susceptibility is fluctuated between 4 and 131 SI $\times 10^{-8}$ m^3kg^{-1}. The magnetic susceptibility of PL03 has three or four peaks at around 5, 24, 57 and 88 cm. The magnetic susceptibility of PL03 and section 1 – 3, 6 – 8 of PC03 vary significantly, but that of section 4 – 5, 9 – 10 of PC03 varies a little. The sandy layers are shown high magnetic susceptibility values (100 – 131 SI $\times 10^{-8}$ m^3kg^{-1}).

[PL04 and PC04]

PL04 and PC04 were conducted on the south of the block like landslide deposit (Fujiwara et al., 2012) at Japan Trench, at 38°01.4348'N and 144°00.2359'E. The water depth was 7554 m. The pilot and piston cores are 75.0 and 961.1 cm long, respectively.

The pilot core and piston core sediments consist of graded dark olive (brownish) silty clay unit, olive black diatom silty clay unit and grayish olive silty clay, are same as PL03 and PC03. Olive black diatom silty clay unit has olive black silty clay (including black fragment) and grayish olive clay (ooze). This core has thicker ooze layer than any other core. Whitish volcanic ash layer is seen at 486.3 cm of PC04.

The magnetic susceptibility is fluctuated between 5 and 92 SI $\times 10^{-8}$ m^3kg^{-1}. That of PL04 has two peaks at around 35 and 70 cm and that of PC04 is higher value downward.

[PL05 and PC05]

PL05 and PC05 were conducted on top of the block like landslide deposit (Fujiwara et al., 2012) at Japan Trench, at 38°04.4927'N and 143°59.4269'E. The water depth was 7517 m.
The pilot and piston cores are 86.0 and 461.2 cm long, respectively. The pilot and piston core sediments consist of graded dark olive (brownish) silty clay and olive black diatom silty clay, are same as PL01 and PC01. PC05 has sandy layer at 458.2 – 461.2 cm.

The magnetic susceptibility is fluctuated between 5 and 56 SI $\times 10^{-8}$ m^3kg^{-1}. The magnetic susceptibility of PL05 has two or three peaks at around 6, 35 and 55 cm. The magnetic susceptibility of section 1 – 3 of PC05 varies significantly, but that of section 4 – 5 of PC03 varies a little.

[PL06 and PC06]

PL06 and PC06 were conducted on the southeast of the block like landslide deposit (Fujiwara et al., 2012) at Japan Trench, at 38°03.0143'N and 144°00.4309'E. The water depth was 7541 m.
The pilot and piston cores are 78.0 and 917.2 cm long, respectively. The pilot and piston core sediments consist of graded dark olive (brownish) silty clay, olive black diatom silty clay and grayish olive silty clay (including cocolith), are same as PC03, PC04.However, grayish olive silty clay is shallower horizon than PC03 and PC04. This core has a few sandy layers. Sandy layer at 809.3 – 816.3 cm has ripple cross-lamination. Volcanic ash layer is seen at 486.3 cm of PC06.PC06 core sediment below 500 cm has much gas.

The magnetic susceptibility is fluctuated between 5 and 161 SI $\times 10^{-8}$ m^3kg^{-1}. The sandy layers (around 291.2 and 301.2 cm) are shown high magnetic susceptibility values (160 SI $\times 10^{-8}$ m^3kg^{-1}).

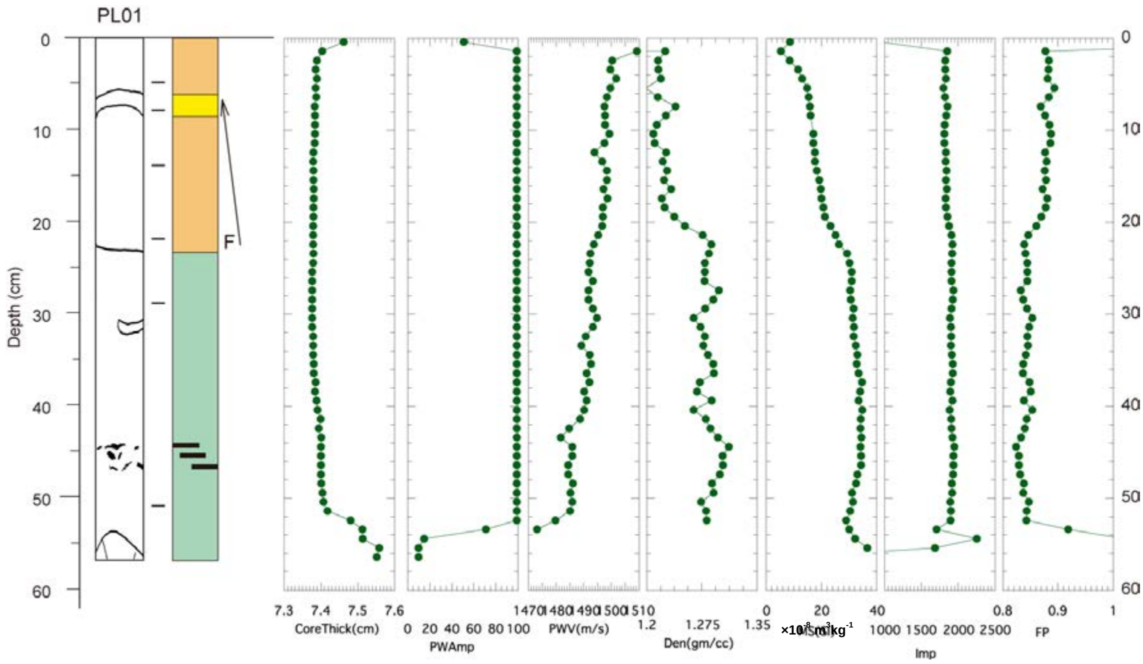

Figure 5.2.2.2: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PL01

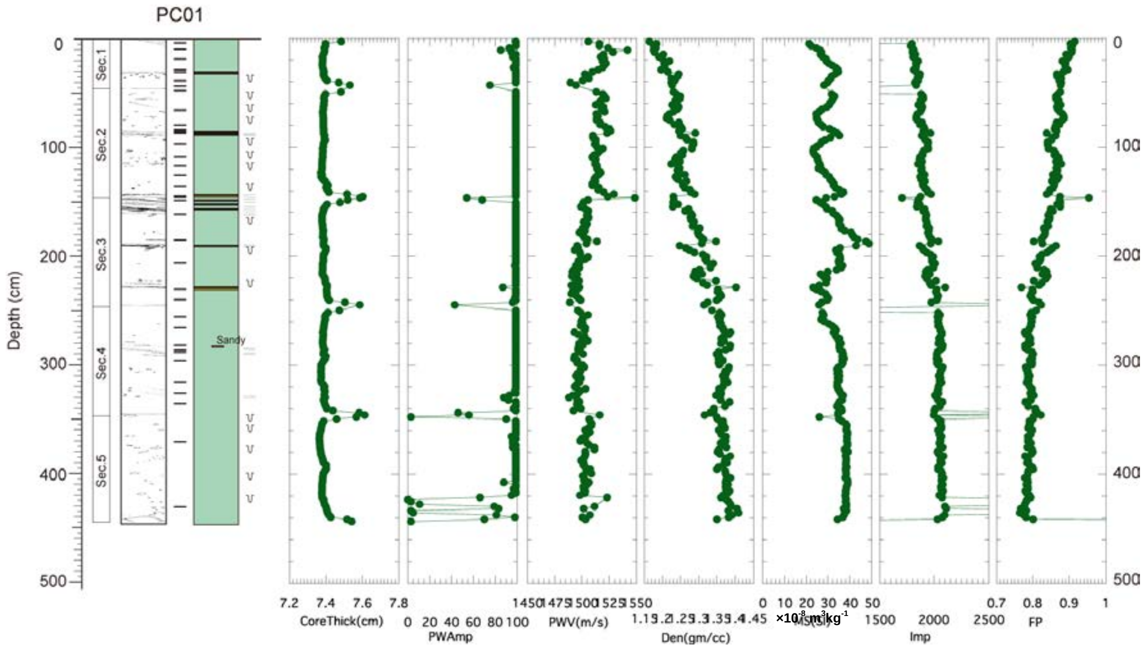

Figure 5.2.2.3: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PC01

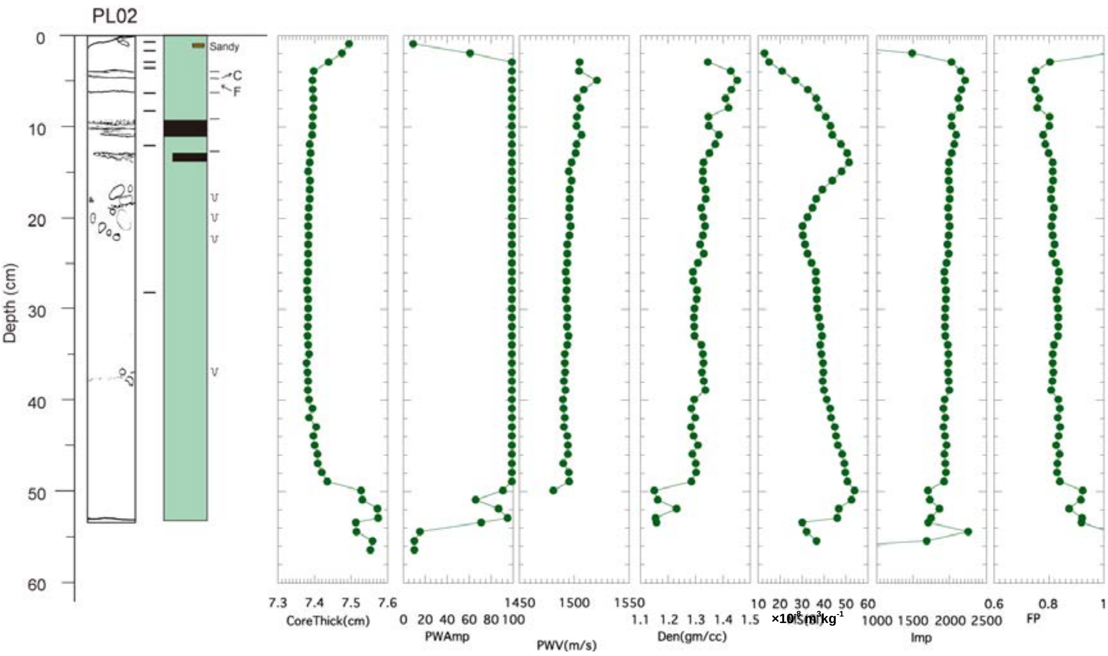

Figure 5.2.2.4: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ -ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PL02

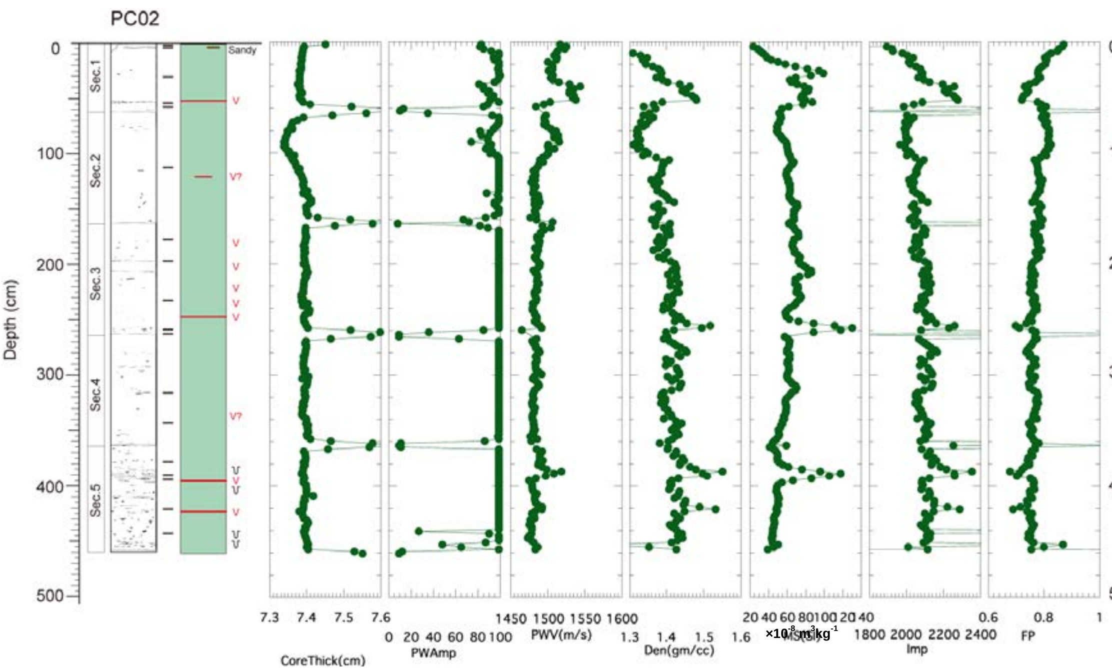

Figure 5.2.2.5: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ -ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PC02

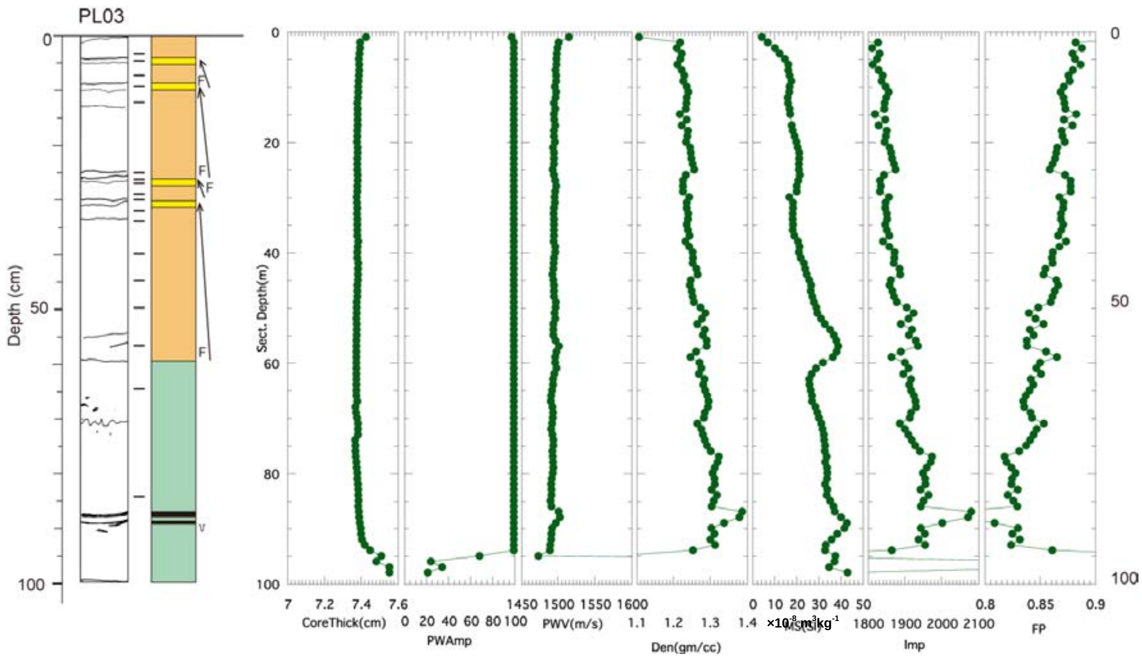

Figure 5.2.2.6: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PL03

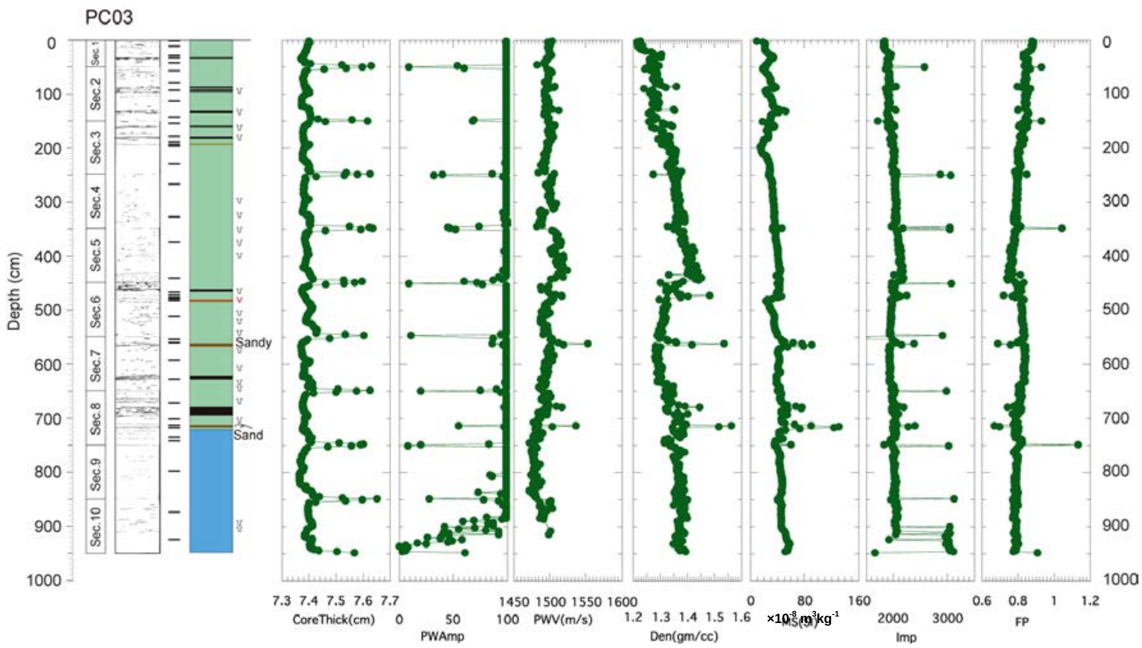

Figure 5.2.2.7: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PC03

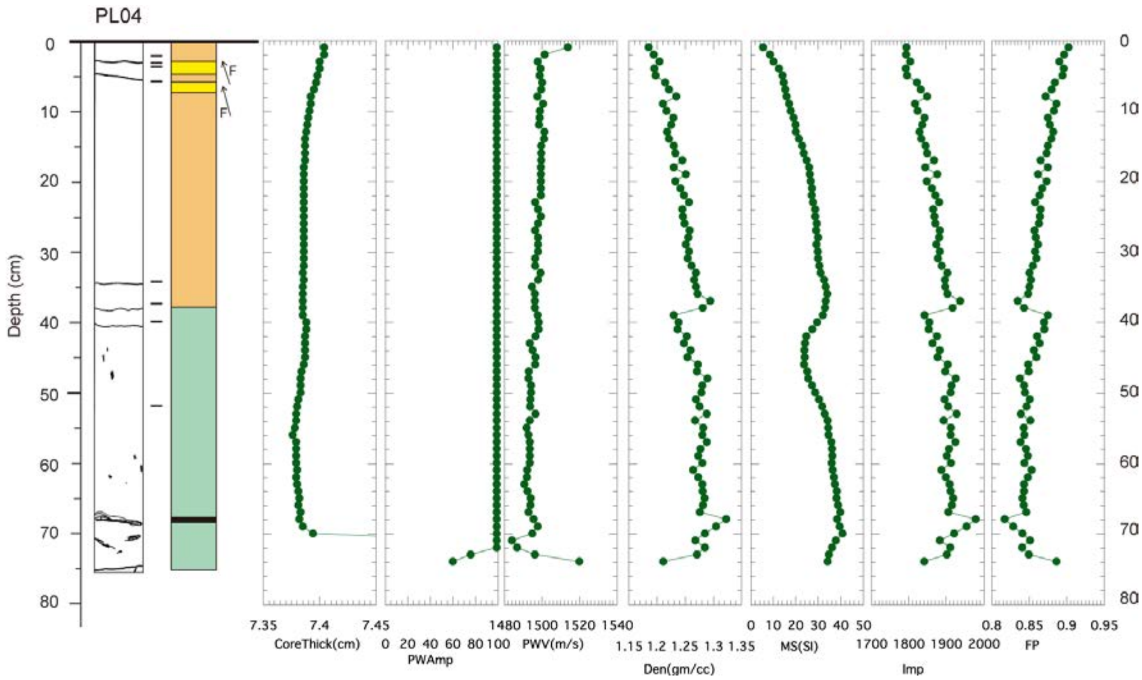

Figure 5.2.2.8: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PL04

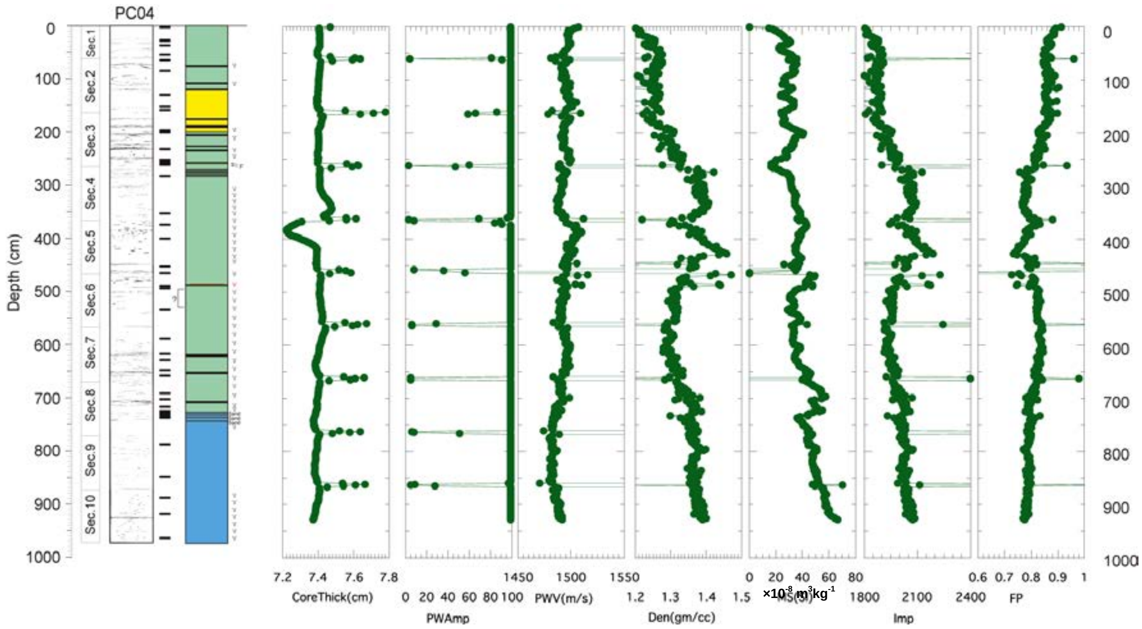

Figure 5.2.2.9: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PC04

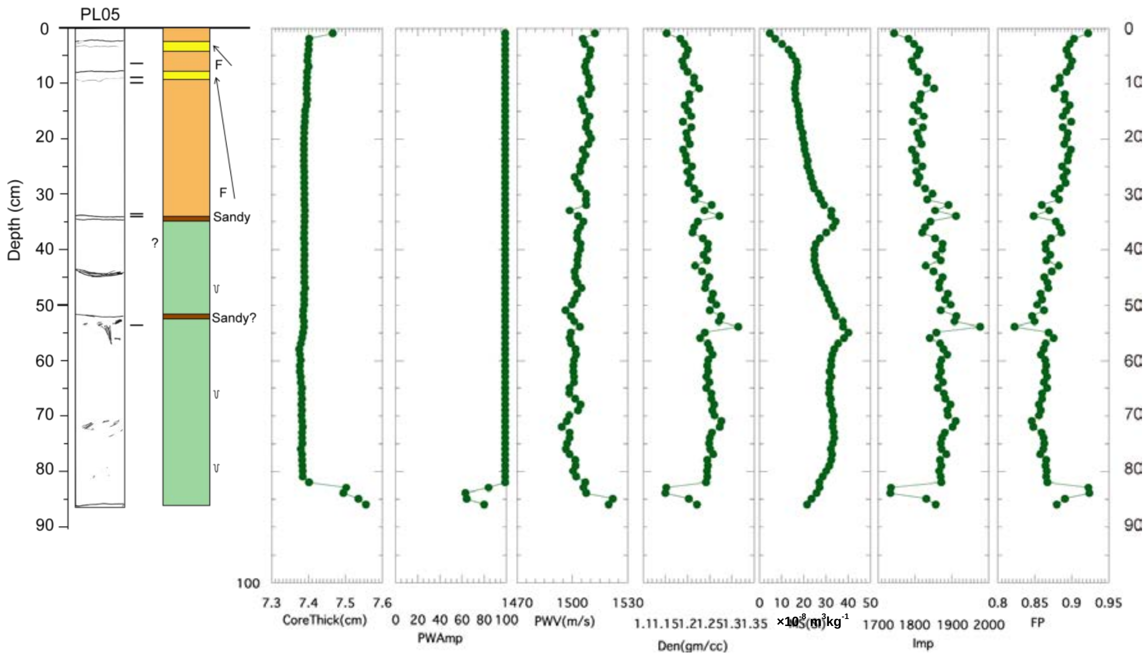

Figure 5.2.2.10: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PL05

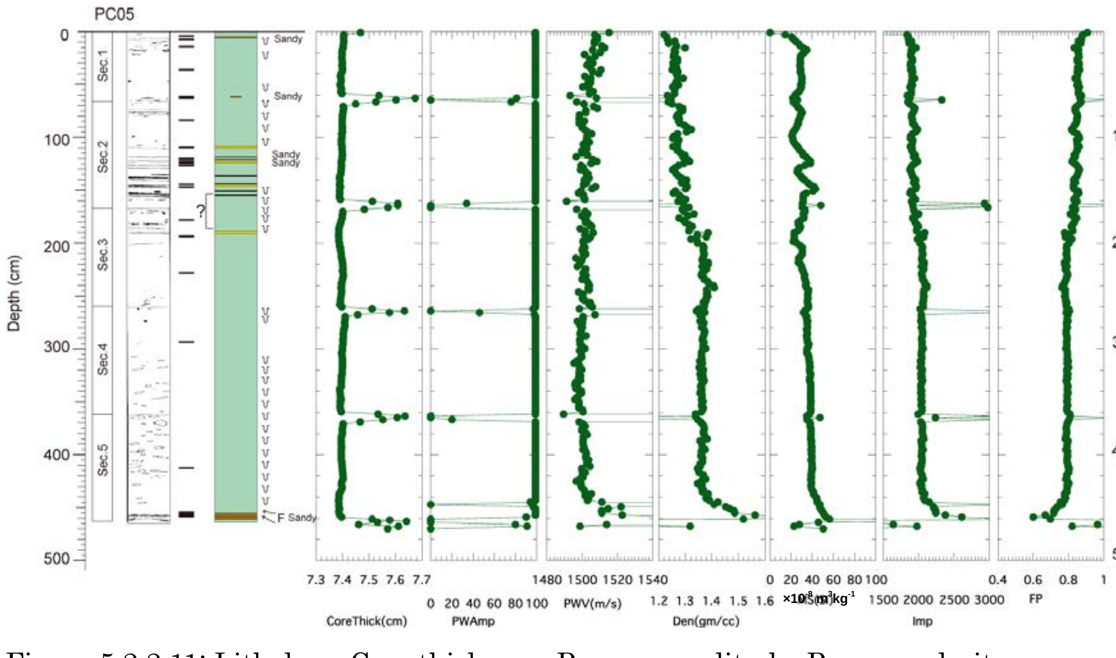

Figure 5.2.2.11: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PC05

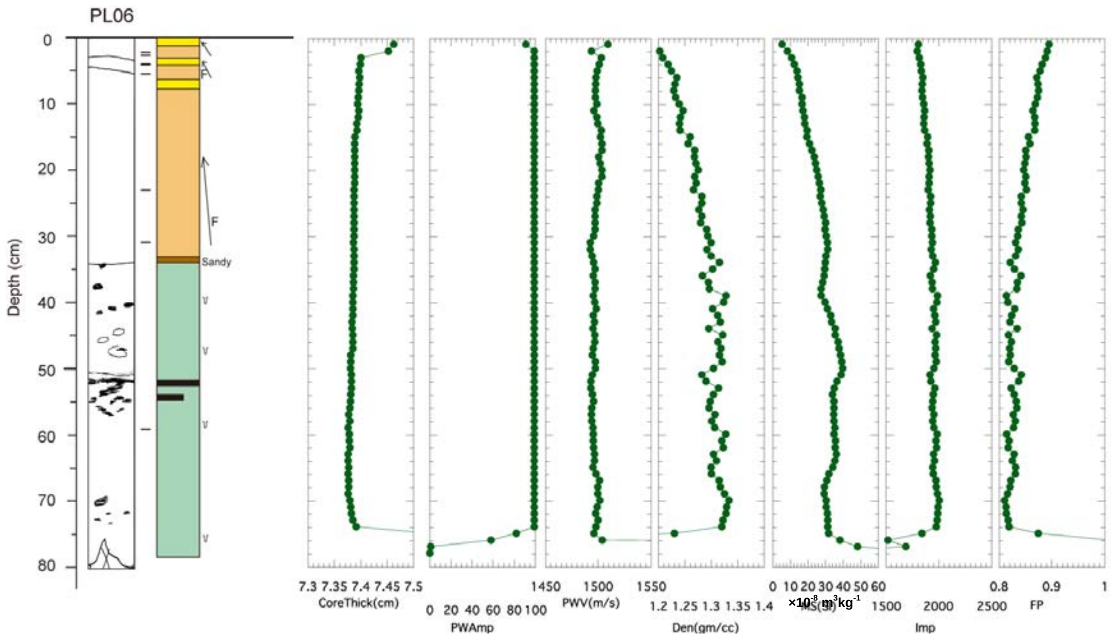

Figure 5.2.2.12: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PL06

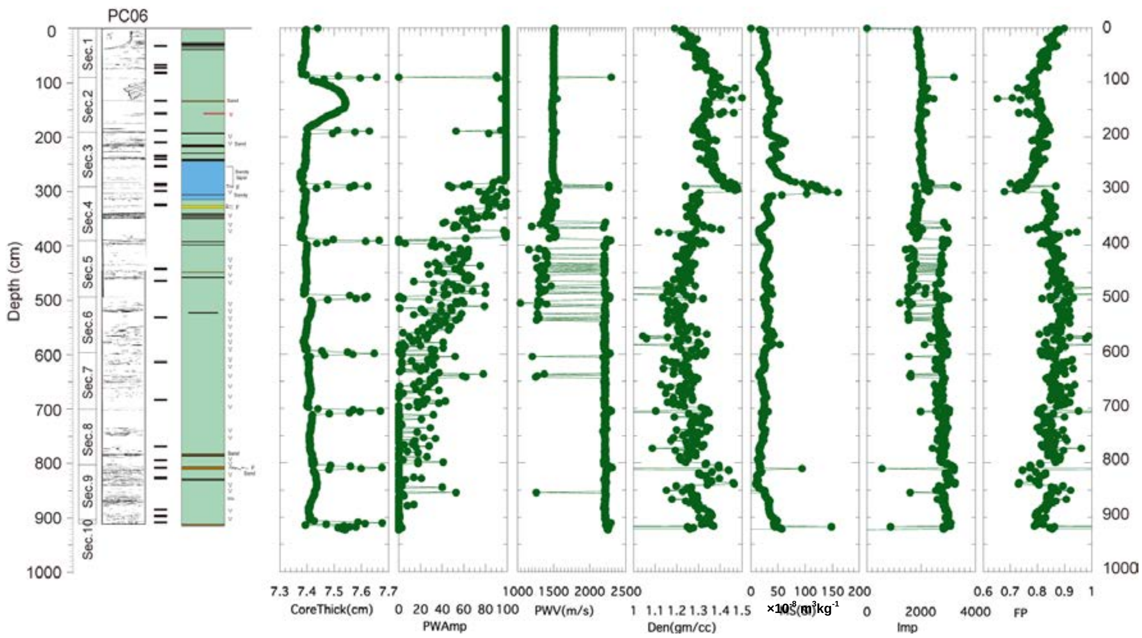

Figure 5.2.2.13: Lithology, Core thickness, P-wave amplitude, P-wave velocity, γ-ray density, magnetic susceptibility, Acoustic impedance, and Fractional porosity of PC06

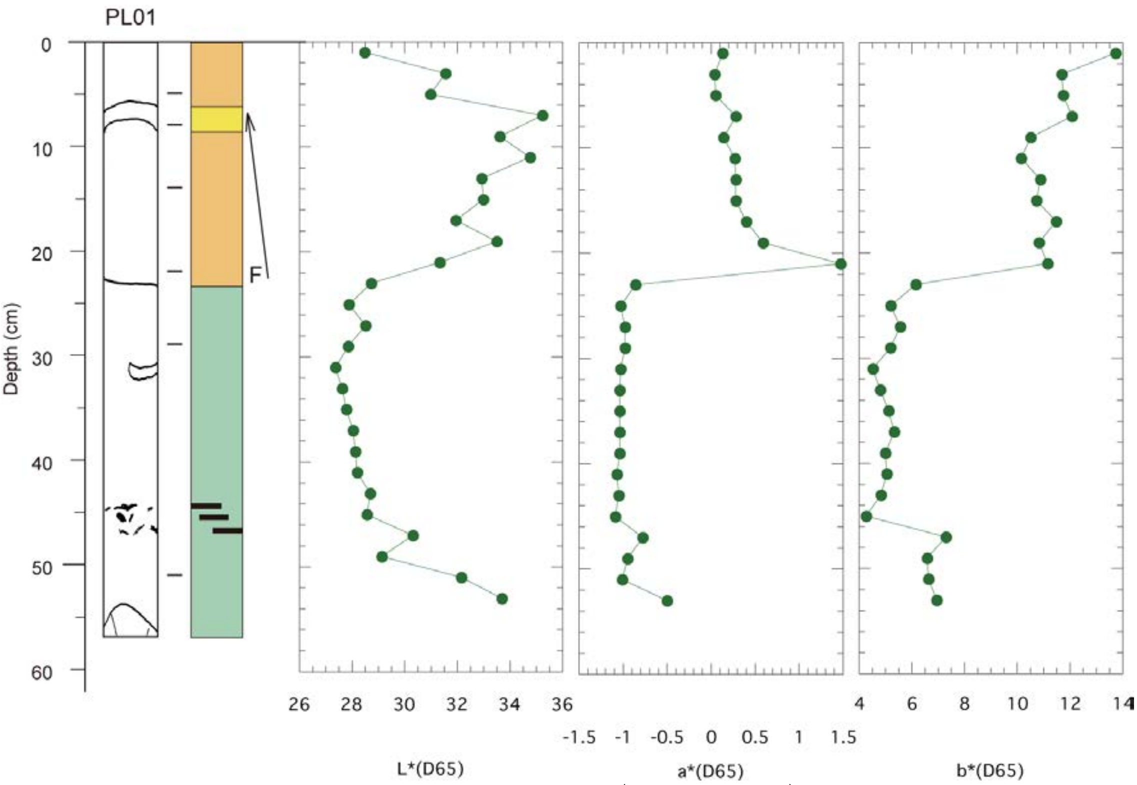

Figure 5.2.2.14: Core color reference variations (L*, a*and b*) of PL01.

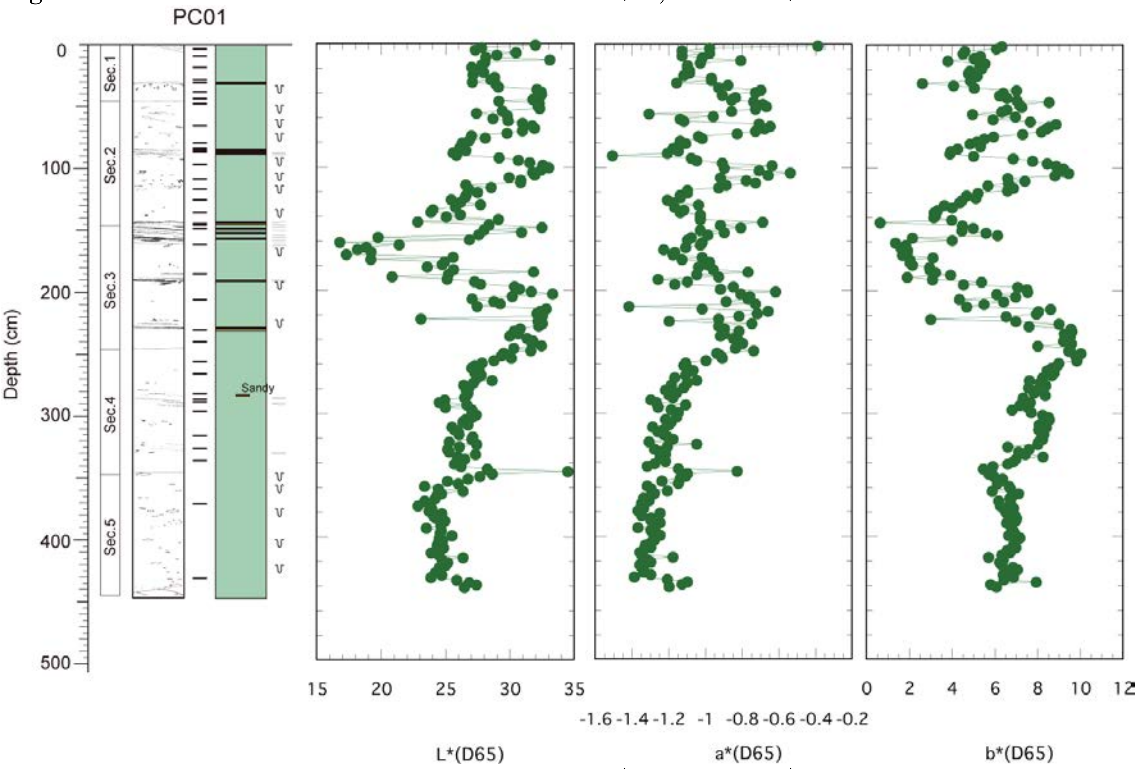

Figure 5.2.2.15: Core color reference variations (L*, a*and b*) of PC01.

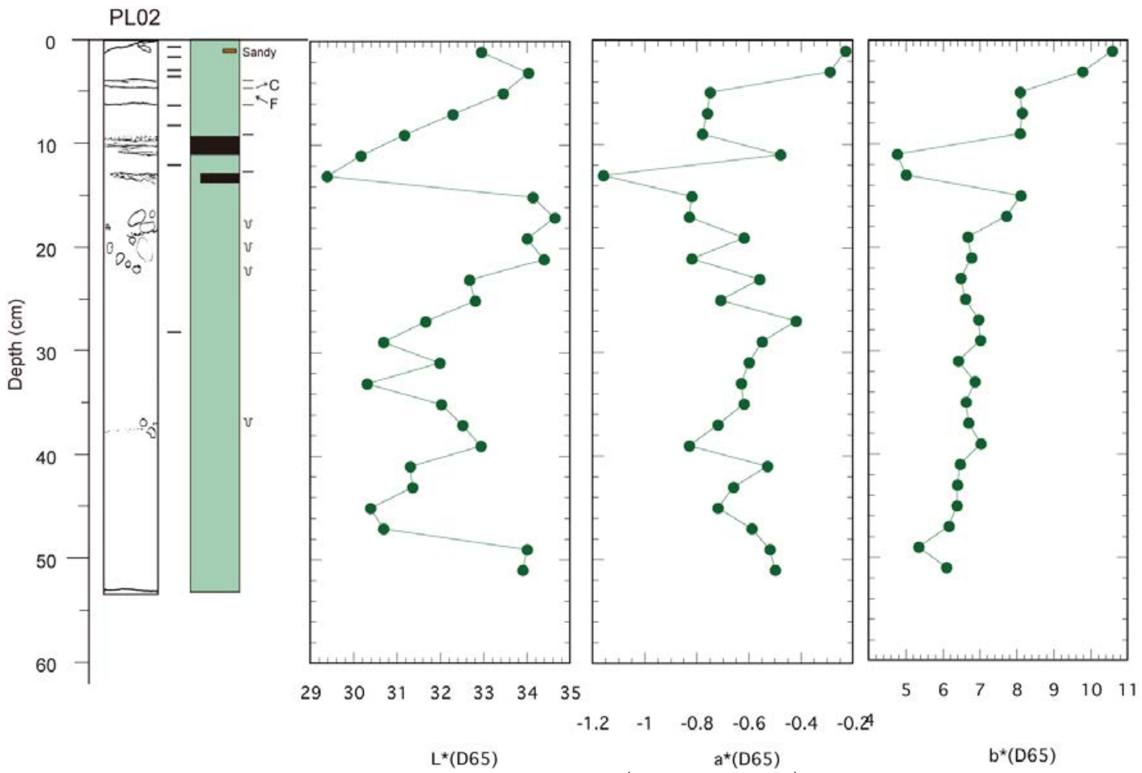

Figure 5.2.2.16: Core color reference variations (L*, a*and b*) of PL02.

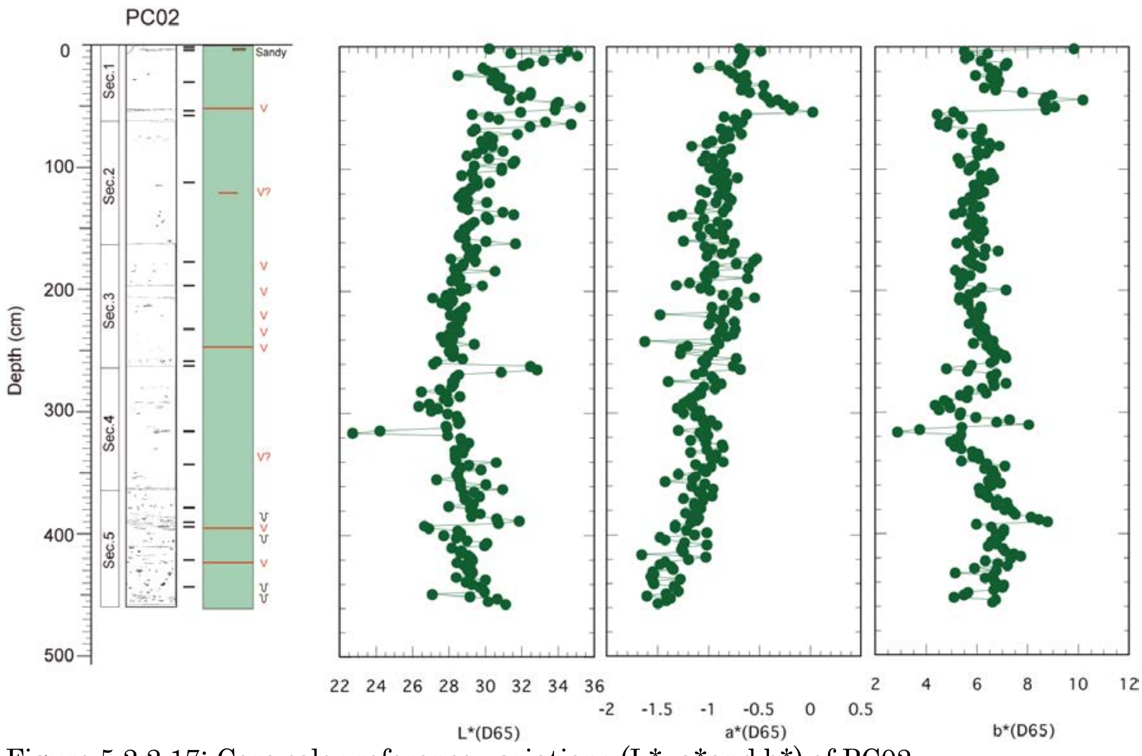

Figure 5.2.2.17: Core color reference variations (L*, a*and b*) of PC02.

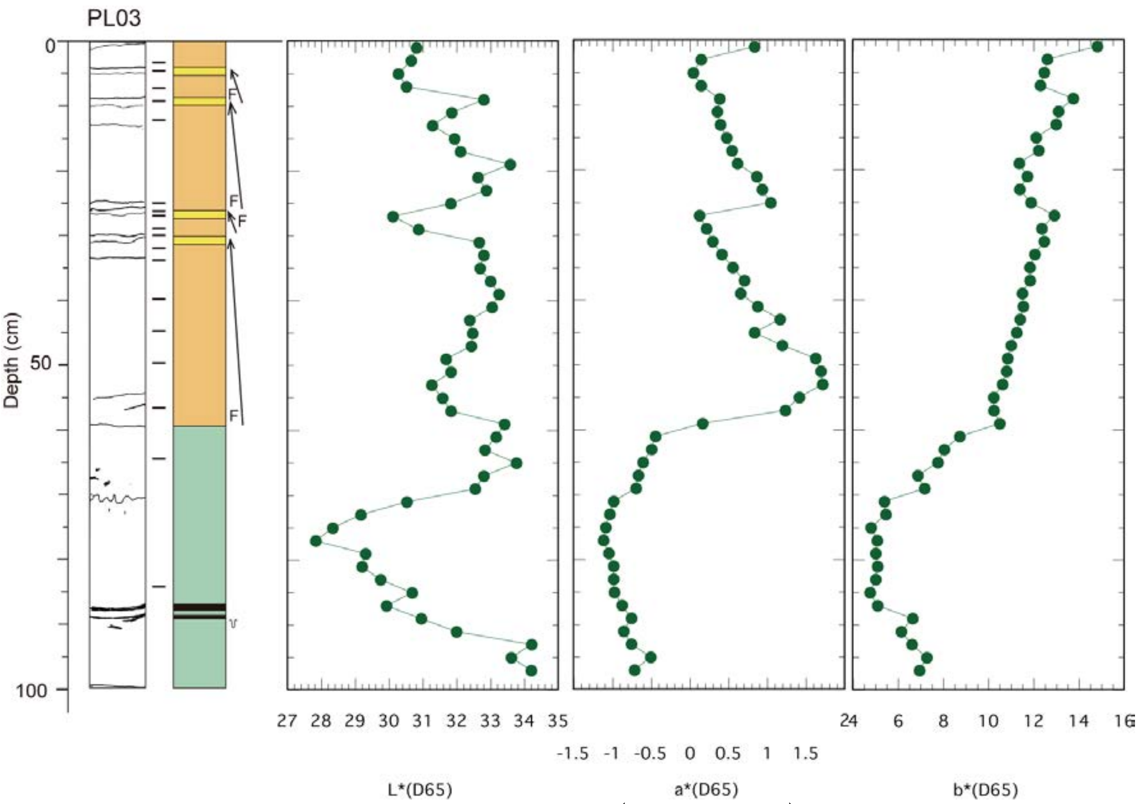

Figure 5.2.2.18: Core color reference variations (L*, a*and b*) of PL03.

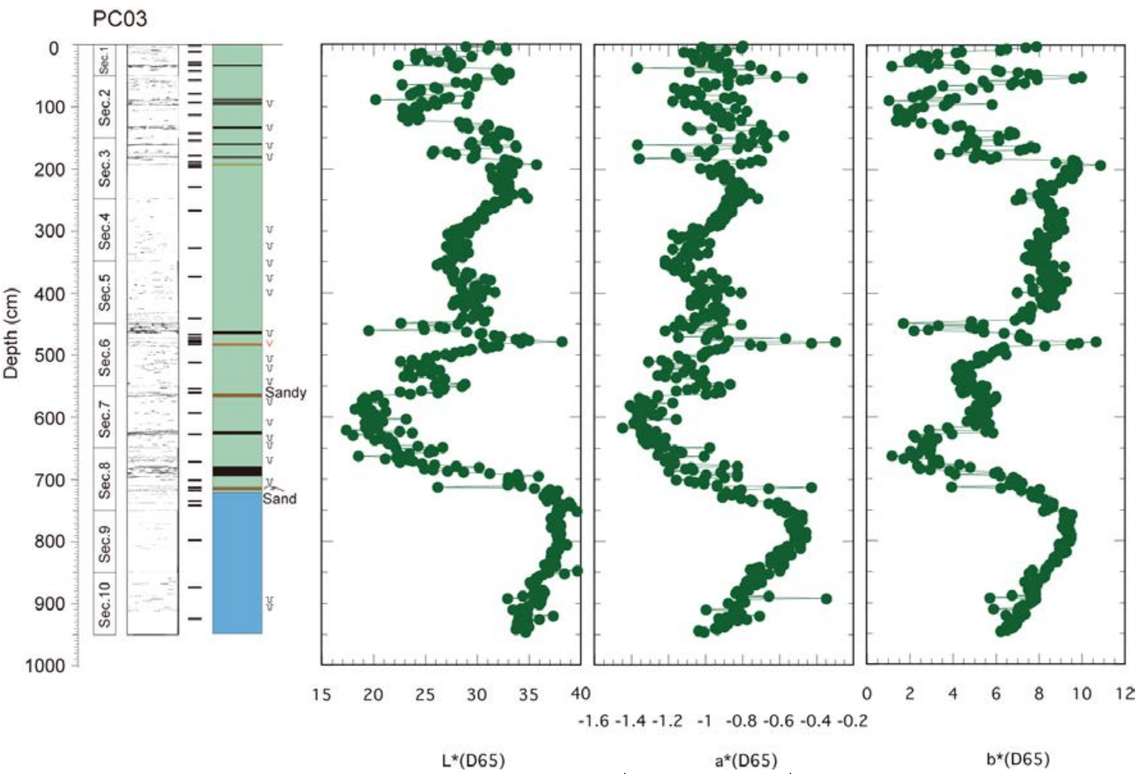

Figure 5.2.2.19: Core color reference variations (L*, a*and b*) of PC03.

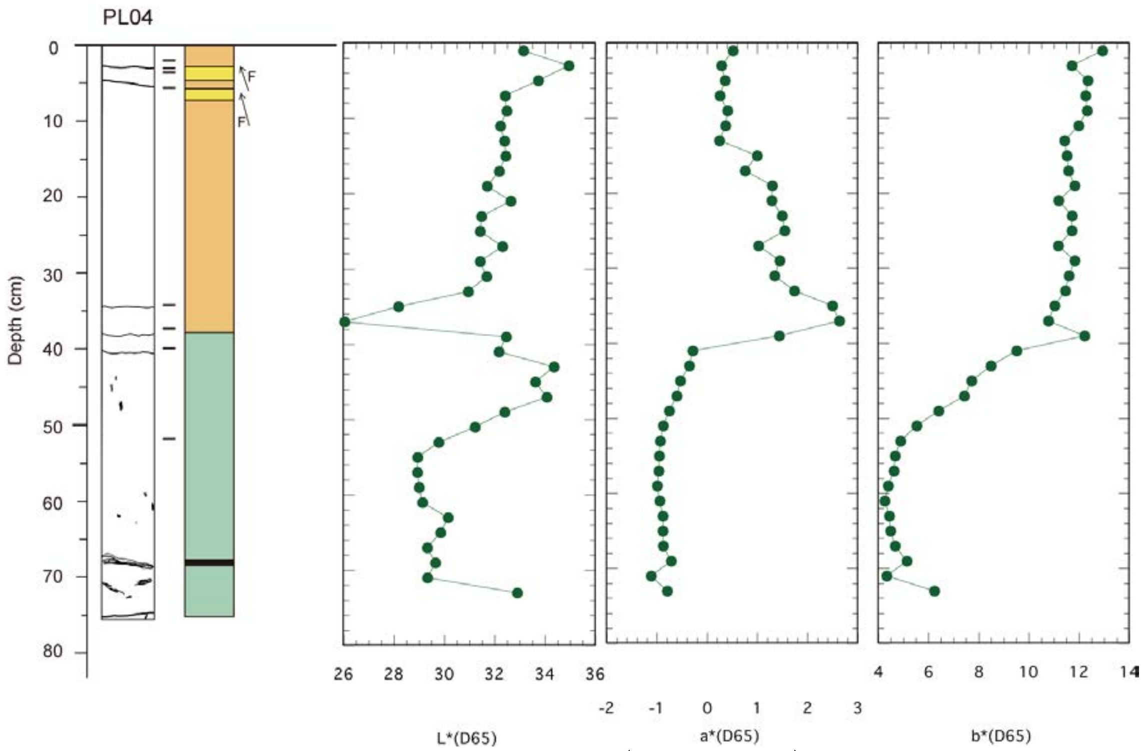

Figure 5.2.2.20: Core color reference variations (L*, a*and b*) of PL04.

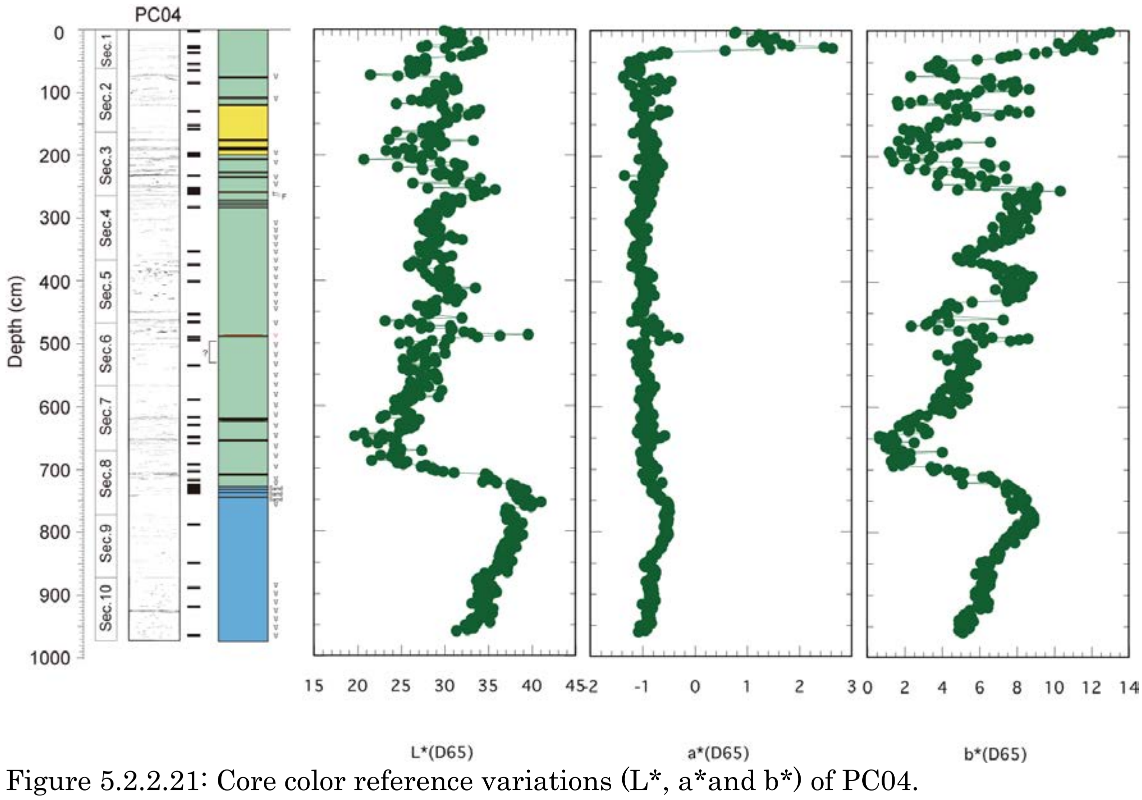

Figure 5.2.2.21: Core color reference variations (L*, a*and b*) of PC04.

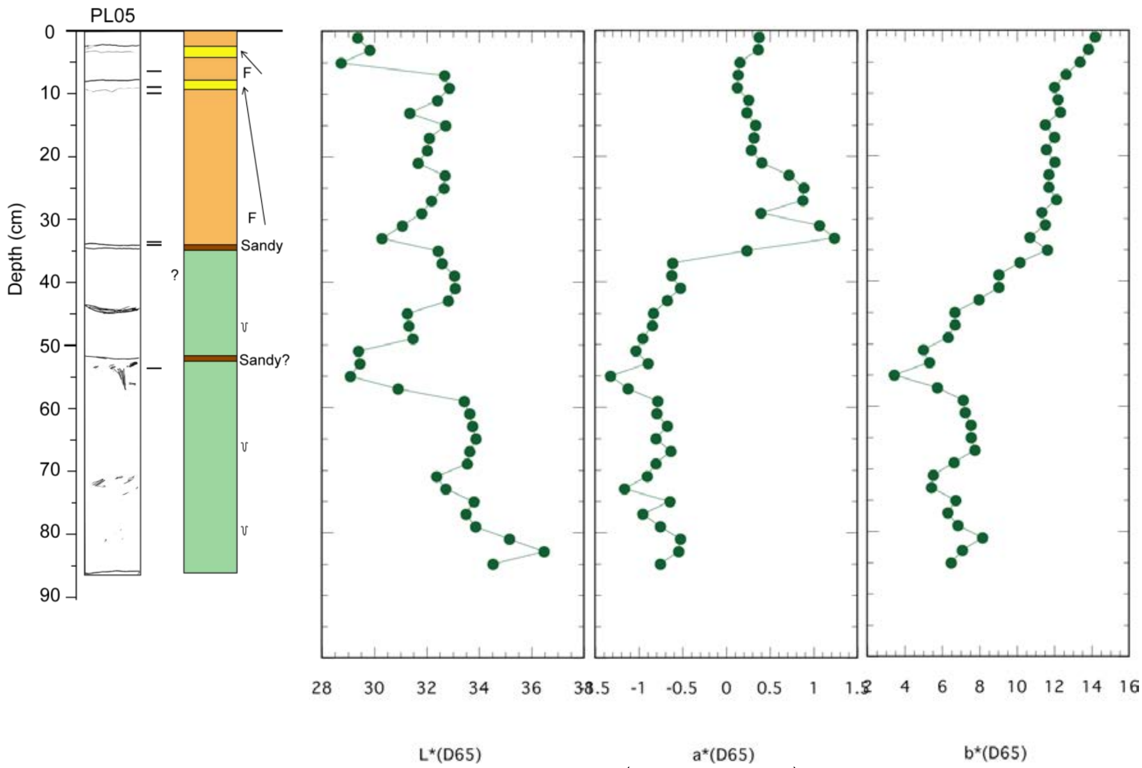

Figure 5.2.2.22: Core color reference variations (L*, a*and b*) of PL05.

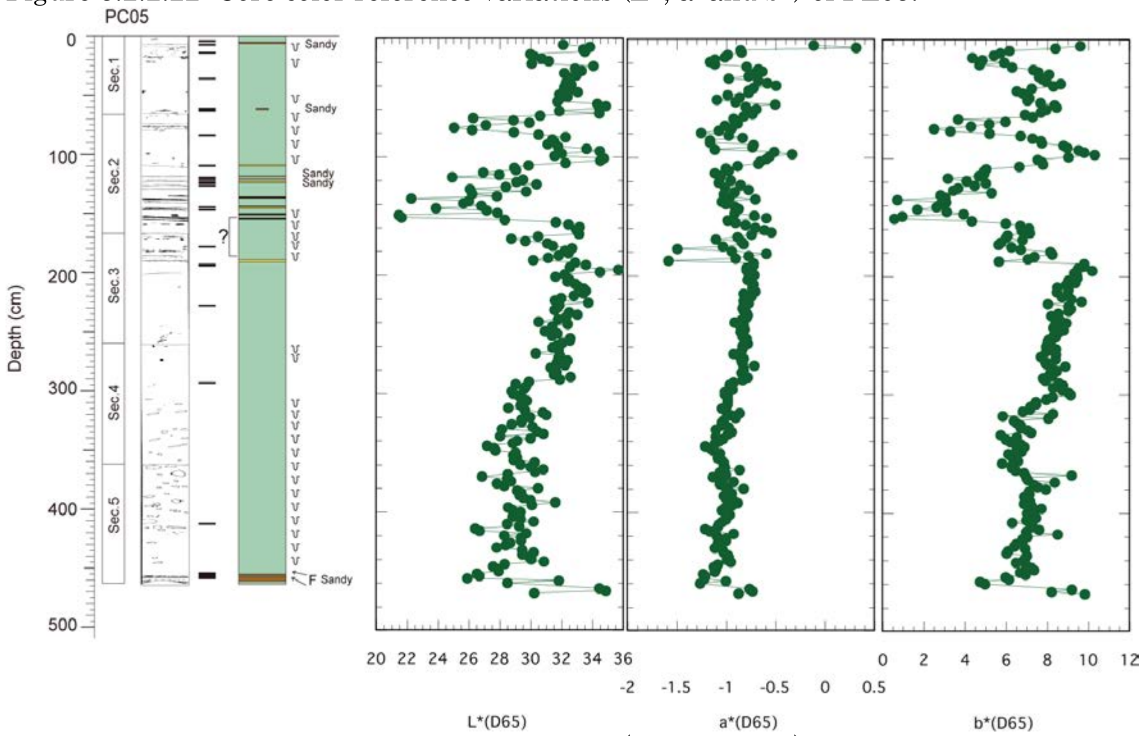

Figure 5.2.2.23: Core color reference variations (L*, a*and b*) of PC05.

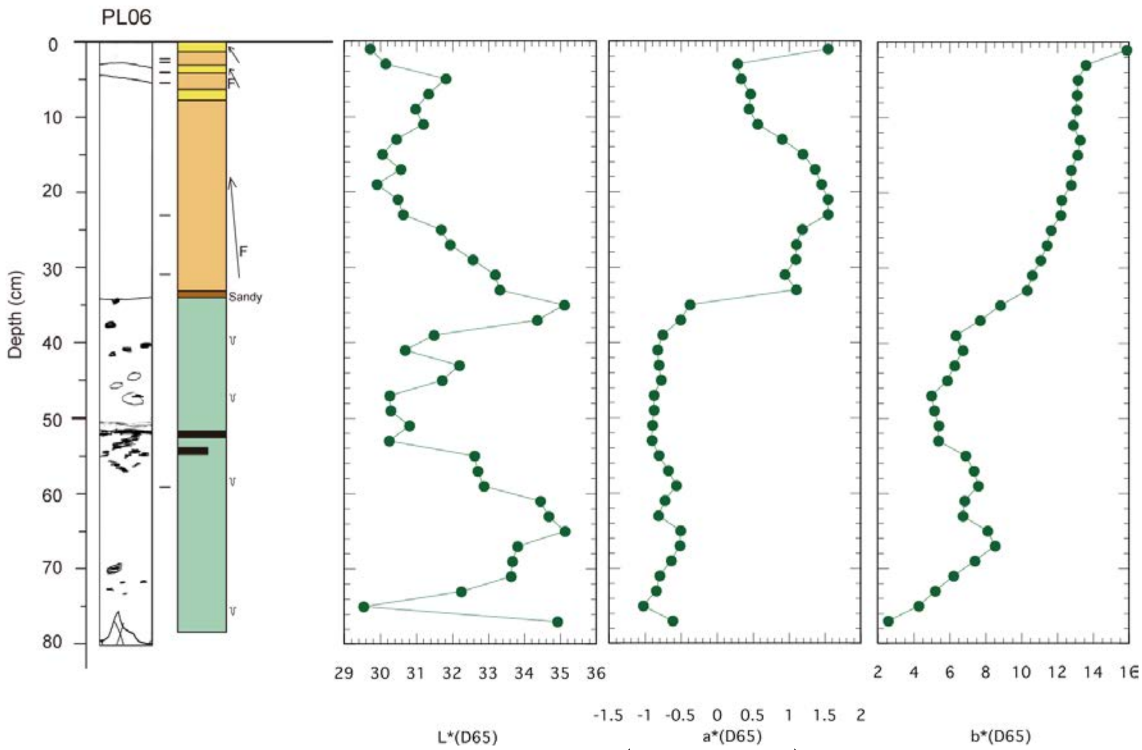

Figure 5.2.2.24: Core color reference variations (L*, a*and b*) of PL06.

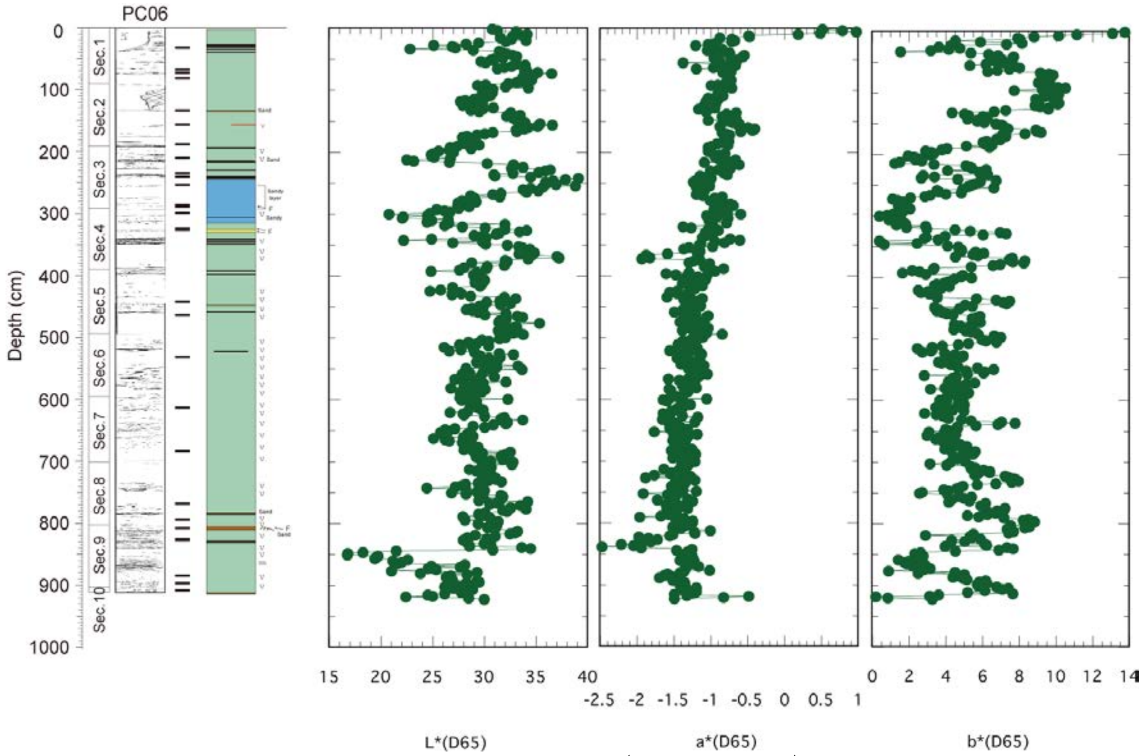

Figure 5.2.2.25: Core color reference variations (L*, a*and b*) of PC06.

5.3 BBOBS and OBS deployment

We successfully deployed six BBOBSs and eight OBSs off Boso area. They were launched by multi-joint crane on R/V Mirai. After BBOBSs settled on the sea floor, we communicated with them using the acoustic transponder to check the status of leveling unit. We started recording manually at site BB1, BB2 and BB4. We calibrated the location of BBOBS stations at site BB2 and BB4 by measuring slant range between R/V Mirai and the settled BBOBS at three points around the launching position. BBOBSs at site BB3 and BB4 were installed Differential Pressure gauge (DPG). For OBSs, we didn't deploy two of ten that had been prepared for observation because instrumental trouble had occurred on board. We communicated with sinking OBS using the acoustic transponder down to about 300-500 m below the sea surface. Both of the BBOBS and the OBS can record seismic signal for about one year.

Fig. 5.3.1 Installation operation by multi-joint crane on R/V Mirai

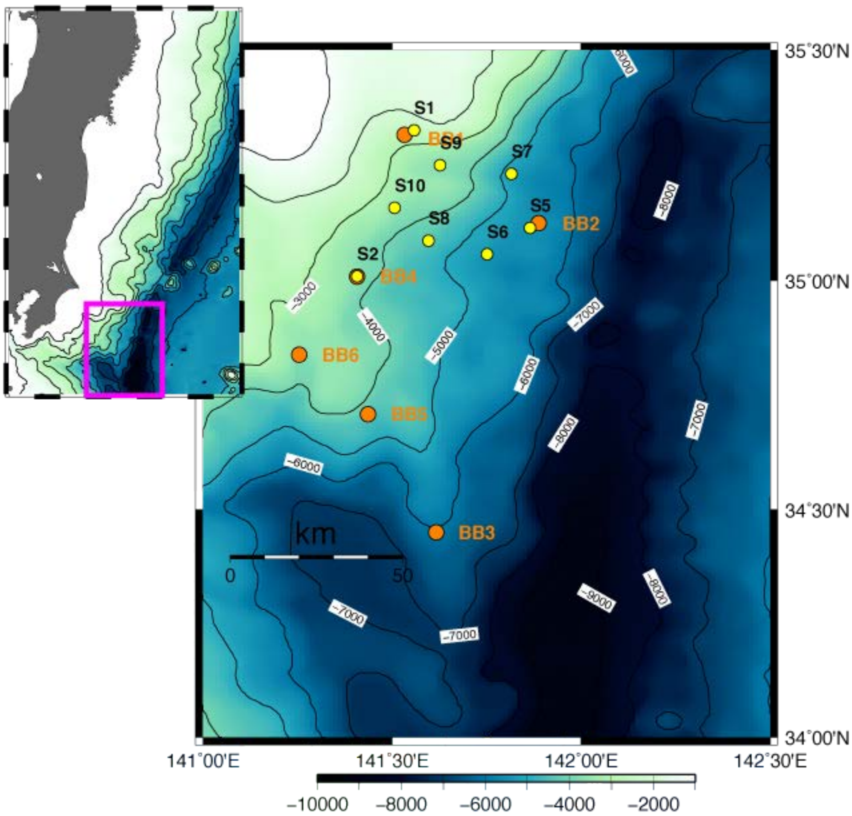

Fig. 5.3.2 Locations of BBOBS (orange circle) and OBS (yellow circle) stations deployed off Boso area. Site "BB" and "S" mean BBOBS and OBS stations, respectively

Table 5.3.1 Deployment information

Site	Planned Position		Deployment information				Remarks
			Time	Vessel position			
	Lat(N)	Lon(E)	UTC	Lat(N)	Lon(E)	Depth(m)	
BB1	35_19.00	141_32.00	2012/2/26 21:09:48	35_18.4943	141_32.1168	2877	
BB2	35_07.50	141_53.30	2012/2/27 1:52:00	35_07.4536	141_53.4536	5628	Calibrated
BB3	34_27.00	141_37.00	2012/3/2 1:45:42	34_26.9935	141_36.9687	5993	With DPG
BB4	35_00.50	141_24.50	2012/2/27 7:51:32	35_00.5059	141_24.5438	3794	Calibrated, With DPG
BB5	34_42.50	141_26.20	2012/3/2 4:37:30	34_42.6028	141_26.2698	4421	
BB6	34_50.30	141_15.30	2012/3/2 6:51:00	34_50.2900	141_15.3010	3571	
S1	35_19.50	141_33.60	2012/2/26 22:34:00	35_19.59500	141-33.55370	2540	
S2	35_00.70	141_24.50	2012/2/27 7:56:15	35_00.56630	141_24.50290	3780	
S3	35_05.00	141_24.20	-	-	-	-	Canceled*1
S4	34_52.15	141_18.20	-	-	-	-	Canceled*1
S5	35_06.90	141_51.80	2012/2/27 2:13:40	35_06.86220	141_51.87340	5800	
S6	35_03.50	141_45.00	2012/2/27 4:35:40	35_03.43550	141-45.13300	5532	
S7	35_14.00	141_49.00	2012/2/27 0:50:40	35_13.90490	141_48.98020	5392	
S8	35_05.20	141_35.80	2012/2/27 5:39:05	35_05.19450	141_35.83610	4683	
S9	35_15.00	141_37.50	2012/2/26 23:32:45	35_15.04730	141_37.64480	3549	
S10	35_09.50	141_30.40	2012/2/27 6:31:20	35_09.50150	141_30.41950	3536	
S11	34_37.50	141_17.50	-	-	-	-	Canceled*2

*1: because of instrumental trouble
*2: spare site

Table 5.3.2 Time schedule

Site	Start time of the recording	End time	Deadline for recovering	Remarks
BB1	2012/2/26 21:45	2013/4/1 0:00	2014/4/1	
BB2	2012/2/27 3:07	2013/4/1 0:00	2014/4/1	
BB3	2012/3/3 12:00	2013/4/1 0:00	2014/4/1	
BB4	2012/2/27 8:39	2013/4/1 0:00	2014/4/1	
BB5	2012/3/3 12:00	2013/4/1 0:00	2014/4/1	
BB6	2012/3/3 12:00	2013/4/1 0:00	2014/4/1	
S1	2012/3/2 23:54	2013/1/16 0:00	2013/5/13 0:00	
S2	2012/3/2 23:59	2013/1/16 0:00	2013/5/13 0:00	
S3	-	-	-	Canceled*1
S4	-	-	-	Canceled*1
S5	2012/3/2 23:56	2013/1/16 0:00	2013/5/13 0:00	
S6	2012/3/2 23:51	2013/1/16 0:00	2013/5/13 0:00	
S7	2012/3/2 23:55	2013/1/16 0:00	2013/5/13 0:00	
S8	2012/3/2 23:58	2013/1/16 0:00	2013/5/13 0:00	
S9	2012/3/2 23:57	2013/1/16 0:00	2013/5/13 0:00	
S10	2012/3/2 23:53	2013/1/16 0:00	2013/5/13 0:00	
S11	-	-	-	Canceled*2

*1: because of instrumental trouble

*2: spare site